VOLUME 41
NUMBER 10

OCTOBER 1954

plating

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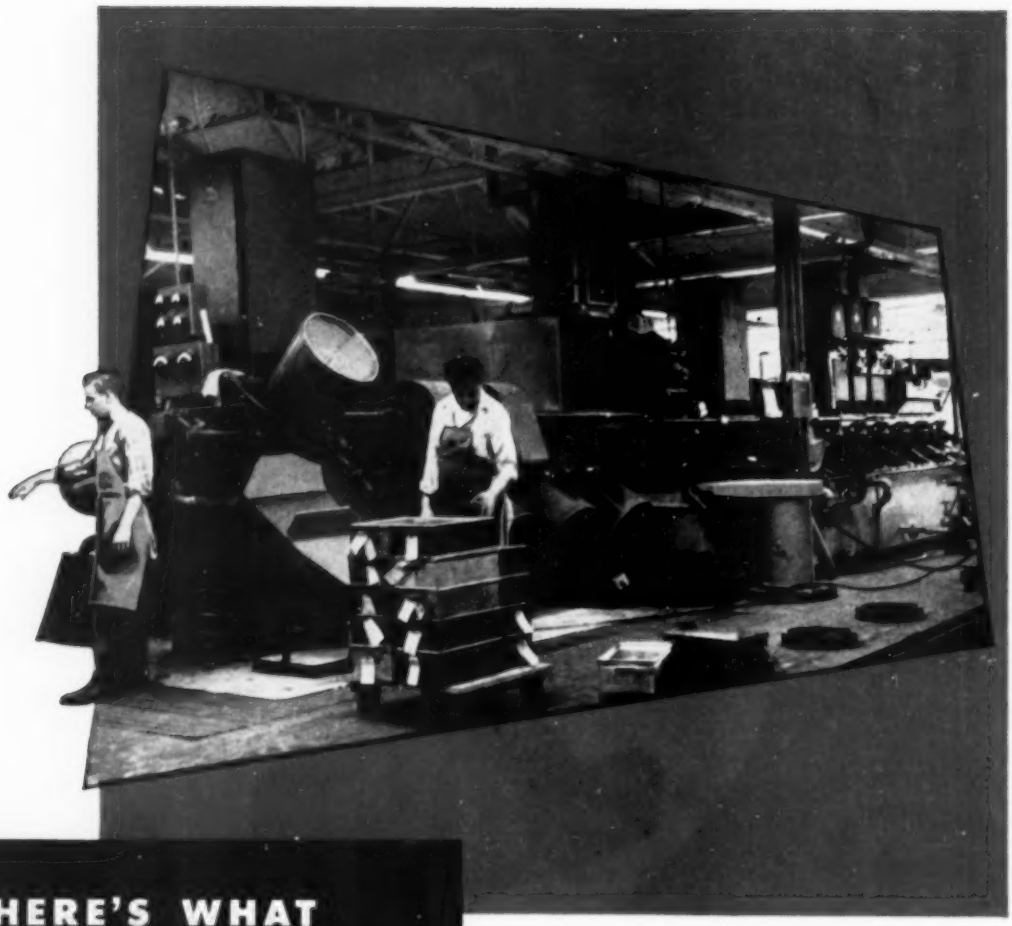

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"The Automatic Barrel Plater pictured here puts the gleam of satisfaction in our customers' eyes. This gleam may well be from the stream of precision-plated SPS products turned out to customer specifications. This fully automatic equipment is used for cadmium plating a vast variety of SPS parts. In a real sense the Automatic Barrel combines industrial ideals of maximum quantity (in a given period of time) and a remarkable quality level. Tolerances to .0001" can be held.

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**Quoted from Standard Pressed Steel Company's house organ, "The Standard Post Script."*

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plating

Journal of the American Electroplaters' Society

Dedicated to the improvement and dissemination of the knowledge of the arts and sciences of electroplating and of finishing of metals and of allied arts

October 1954 **Vol. 41, No. 10**

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This Month's Cover . . .

shows vacuum cleaner parts being polished prior to plating. Photo courtesy Norton Company, Worcester, Mass.

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Editorial

Why Do I Belong to AES?

"EVERY man has business and desire," says Shakespeare's Hamlet.

My business is my job, and my desire is for a full life . . . a desire which can materialize only through combining my business, or obligation to my family, my company, my community, and myself, with the need to know, to help, to serve, and to enjoy people.

Through the many activities of AES—monthly meetings, regional meetings, special functions, annual conventions, and PLATING—we have every opportunity to find the knowledge that helps us to do a better job. We meet people with different ideas than our own, and they become lifelong friends. We serve our neighbors in plating by speaking formally or informally, by acting as elected officers, or by advising those who ask our advice. By such participation we achieve a more abundant life.

AES enables us to make an organized contribution, not only to our business of electroplating, but to our business of living. It serves you and me as a measuring stick of accomplishment.

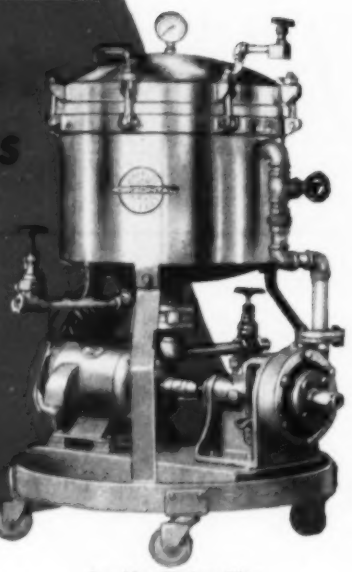
That's why I'm a member of the American Electroplaters' Society.

Francis T. Eddy

THIRD VICE-PRESIDENT, AES

FOR LOW COST FILTERING OF PLATING SOLUTIONS

SPARKLER HORIZONTAL PLATE FILTERS



Sparkler Plating Filter
Model 18-D-6 Alliron
600 G.P.H. Portable

HERE'S HOW

★ On a horizontal filter plate it is possible to apply a thin pre-coat with about one-third the filter aid, and in one-third the time required for pre-coating a non rigid media or a surface in a vertical position. This saves time and filter aid.

★ Where several tanks are to be filtered, the Sparkler filter can be shut down after filtering the first tank and moved to the next one without danger of disturbing the filter cake. This saves pre-coating time and filter aid usually required to re-coat a bag-type filter.

★ A filter cake on a horizontal plate will not crack, slip or fall off even with varying pressure or a complete shut-down of the filter. No pre-coat renewal is ever required after an interruption in operation.

★ When it is necessary to clean the filter, the Sparkler filter tank can be emptied in a matter of minutes with a minimum of loss of valuable plating solution.

★ Any grade of filter paper from fine to coarse can be used in a Sparkler filter. This makes it ideal for carbon treatment of solutions. Carbon mixed with water in a stand-by tank is circulated through a clean set of filter paper on the plates until a carbon cake is formed. The solution requiring carbon treatment is then circulated through the carbon beds without contaminating the plating tank or a shutdown of plating operations.

★ At the end of the cycle with a Sparkler filter you can blow-down with air and produce a relatively dry cake that can be disposed of in a trash can rather than washing it down the drain with attendant sewer clogging problems.

★ You will find your Sparkler plating filter positive and dependable from a standpoint of uniform high quality filtering and economical in labor and material.

SPARKLER

Sparkler representatives in all principal cities are ready to give you personal service on your filtering problems, and show how you can make a material saving in operating cost.

MANUFACTURING COMPANY
Mundelein, Illinois

European Plant
Amsterdam, Holland

Canadian Plant
Galt, Ontario

Industry News

Special Libraries Association to Present Metals Program. The metals division of the Special Libraries Association in conjunction with the American Society for Metals will present its fifth annual program at the National Metals Exposition and Congress in Chicago, November 1–5, 1954.

A staff of technical literature specialists will offer on-the-spot reference service to all attending the convention. Free reference material—contributed bibliographies, SLA literature, and reprints—will be distributed. Periodicals, government publications, new technical books, and SLA publications will be displayed as a guide to trends in technical literature.

A three-day program has been arranged by a special committee under the chairmanship of Charles Wolfenberger of Acme Steel. It opens on Wednesday, November 4, with a guided tour of the John Crerar Library of Chicago. Librarian Herman H. Henkle will explain library policies, followed by a panel discussion by staff members.

The small metallurgical library will be the subject of Thursday morning's session at the Conrad-Hilton Hotel, presided over by Margaret Fuller, librarian of the American Iron and Steel Institute and chairman of the metals division, SLA.

Marjorie O. Baker, librarian of Baker and Company, Inc., will discuss methods of starting such a library. William S. Budington, associate librarian of the Crerar Library, will speak on "The

Classified Advertisements

Only "Help Wanted" and "Situations Wanted" will be accepted. Rates: $.20 per word, minimum $5.00. AES branch members and members-at-large, in good standing, are entitled to a total of three *free* advertisements in one year. Last day for inserting advertisements is the 10th of month preceding date of publication. When answering advertisements please address as follows: Box number, PLATING, 445 Broad Street, Newark 2, N. J.

WANTED—Editor, with at least 3 years' experience, over 33, by NY area technical journal of long-standing. Must be college graduate. Knowledge of chemistry and electrochemistry desired. Vacation and sick leave with pay, paid hospital plan and other fringe benefits. Salary open. Candidate should have ability to write "non-technical" articles and should be imaginative. The right spot for the person who wants more than just a job. Send resume and expected starting salary to: P-1054-A PLATING, 445 Broad St., Newark 2, N. J.

WANTED—Experienced sales representative who can assume full responsibility for established accounts and develop new business for nationally recognized manufacturer of electroplating supplies and equipment. Challenging position with excellent opportunities for qualified man. Salary open. Several territories available in Eastern area. Reply to: P-1054-B, PLATING, 445 Broad St., Newark 2, N. J.

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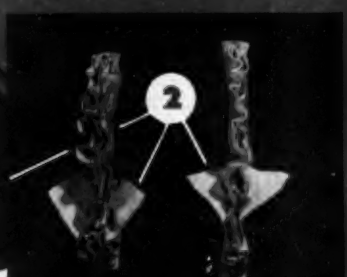

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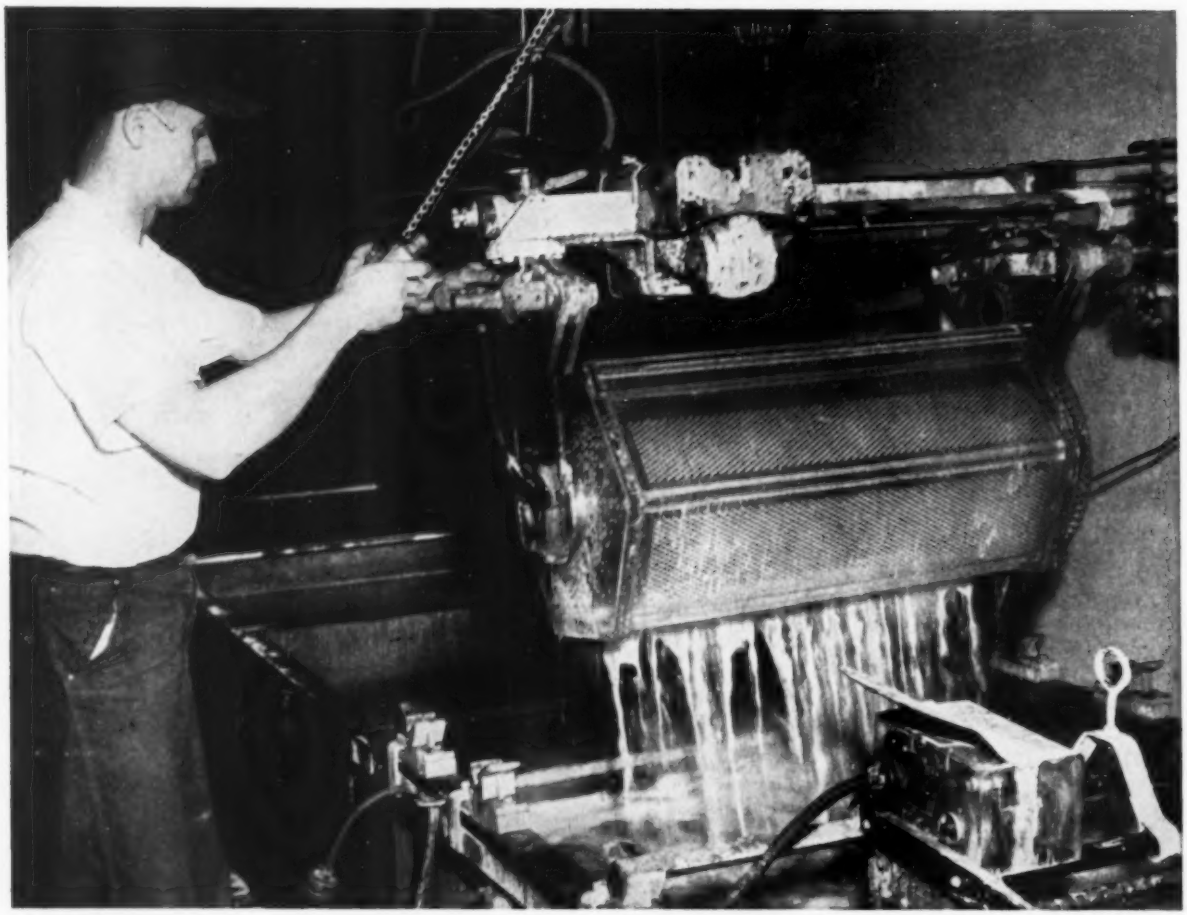

Photo Courtesy Products Finishing Magazine

Job plater finds Pennsalt Cleaners are key to consistently good plating

Varland Metal Service, Inc. of Cincinnati uses three Pennsalt Cleaners . . . finds them versatile, economical, reliable, on a wide variety of parts and metals.

The key to consistently good plating is thorough cleaning. In the job plating field, where competitive position depends on consistently high quality, the selection of a few standard cleaners for a wide variety of items is very important.

That is why Varland Metal Service, Inc., one of the larger job-platers in the Midwest, teamed three Pennsalt Cleaners in their new and modern barrel-plating operation. These three meet their widely varying needs with top efficiency at lowest cost.

1. Pennsalt Cleaner 45—removes heavy soil, makes the electro-cleaning bath last longer.

2. Pennsalt Cleaner K-8—the new Pennsalt electro-cleaner, outstanding for high speed reverse current smut and soil removal.

3. Pennsalt Cleaner Z-54—for cleaning zinc base die castings—to give adherent plate without blistering.

For expert help on any cleaning problem, call your local Pennsalt representative today. His address and phone number are listed on the opposite page. He'll bring a Pennsalt Sales Engineer to analyze your present methods; determine where Pennsalt cleaners can lower costs—improve quality for you. Or write: Metal Processing Dept., Pennsylvania Salt Mfg. Co. *EAST:* 861 Widener Bldg., Philadelphia 7, Pa. *WEST:* 2168 Shattuck Ave., Berkeley 4, California.

Pennsalt Chemicals

ATTENTION JOB PLATERS AND FINISHERS!

Here's a New Local Service Designed For Your Needs!

Pennsalt now provides *direct local* distribution in many areas in addition to their large staff of sales-service engineers and technical service men. The exclusive Pennsalt distributors listed below offer you qualified sales-service on Pennsalt Cleaners *plus* prompt delivery of materials from *local warehouse stocks, in these areas:*

NEW ENGLAND—POUGHKEEPSIE—ALBANY
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BUFFALO—ERIE—WARREN
W. M. Fotheringham Co.
975-981 Niagara Street
Buffalo 13, New York

CLEVELAND—AKRON—YOUNGSTOWN
General Supply Co.
5317 St. Clair Avenue
Cleveland 3, Ohio

CINCINNATI, OHIO
Herbert Chemical Company
Vine Street & Murray Road
St. Bernard

BALTIMORE, MARYLAND
Hughes Chemical Co.
1411 Fleet Street

MUSKEGON—GRAND RAPIDS
M C Supply
2410 Lake Avenue
N. Muskegon, Mich.

READING—PHILADELPHIA—DELAWARE
Textile Chemical Co.
Second & Spruce Sts.
Reading, Pennsylvania

CHICAGO, ILLINOIS
Joseph Turner Company
435 N. Michigan Ave.

INDIANAPOLIS—RICHMOND—NEW ALBANY
Ulrich Chemical Co.
31 E. Georgia Street
Indianapolis, Indiana

WISCONSIN—ROCKFORD—TWIN CITY
J. H. Schneider Co.
4858 N. Berkeley Blvd.
Whitefish Bay, Wisconsin

Contact your local distributor directly or write: Metal Processing Department, Pennsylvania Salt Manufacturing Co., 861 Widener Building, Philadelphia, Pa.

NEWS OF PENNSALT PRODUCTS

Industry News

Paradoxical Trade Catalogue," and Lois W. Brock, research librarian of the General Tire and Rubber Company, will take up the handling of patents in the small library.

Economics and marketing in the metallurgical field will be considered at the afternoon session, presided over by Elsie Ray, librarian of the Anaconda Copper Mining Company. The importance of libraries in market research will be demonstrated by Donald E. Stewart, manager of the data section, commercial research division, United States Steel Corporation. Sources of information on nonferrous metals will be revealed by Irving Lipkowitz, assistant to the president of Reynolds Metals Company.

A field trip to the Inland Steel Company on Friday morning will include a speech by James W. Halley, assistant superintendent of the research and development division of the company.

An inspection of the new research library in the Purdue Extension Building at Hammond, Ind., on Friday afternoon is the final feature of the SLA-ASM program for the fall 1954 meeting.

New Home-Study Course. The Joseph B. Kushner Electroplating School has announced a new specialized home-study course: "Modern Hard Chromium Plating." This is an advanced course for those who have completed "Electroplating Know-How" or who have the equivalent of at least a high school education and three years of plating experience.

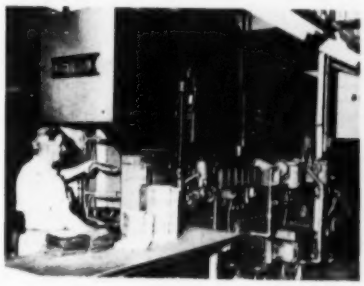
The course covers in detail every division of the subject: properties of chromium deposits; basic facts of metallurgy as required for hard chromium plating; metallurgy of iron and steel; hardness and hardness testing; stress and chrome plating; stress relief methods; hydrogen embrittlement; surface preparation for hard chrome plating; distribution of current in chrome plating baths; racking methods and principles for uniform current distribution; stopping off techniques; dielectric properties of stop-offs; production of porous chrome deposits; finishing of chrome plated surfaces; control and operation of industrial chrome plating baths; solution control and analysis methods and control of impurities; trouble shooting; calculations for specification deposits; chromium plating wastes—disposal and treatment.

All students who successfully complete the course will be awarded a certificate by the school, which is licensed under the Pennsylvania Department of Public Education. Those interested in taking the course should write the Joseph B. Kushner Electroplating School, 115 Broad Street, Stroudsburg, Pa., for complete details.

Stevens Completes Foundry and Warehouse in Canada. Frederic B. Stevens of Canada, Ltd., has announced the completion of a new foundry and metal finishing supply warehouse in Windsor, Ontario, near their present plant and warehouse at 1262 McDougall.

In addition to the complete Stevens line of foundry facings, fire brick, plating chemicals, and metal finishing supplies, Stevens is also stocking in the new warehouse the complete MacDermid metal cleaner and plating solution line, Roto-Finish processes and supplies, and American Colloid Volclay Bentonite and wood flour.

Schick Trims Labor Costs with Detrex Ultrasonic Degreaser. The use of a fully conveyorized ultrasonic metal cleaning machine in the electric shaver plant of Schick, Inc., Stamford, Conn., has reduced labor costs "in excess of 25 per cent."



"In addition," reports T. N. Garry, Schick plant manager, "there have been important costs savings realized through the elimination of rejects by cleaning or lack of cleaning of finely machined shaver parts. Hand brushing prior to inspection has been completely eliminated."

Garry pointed out that in his opinion Schick's most important benefit, obtained when it converted to an ultrasonic cleaning operation in April, 1954, was increased quality due to extreme cleanliness.

He also reported that the ultrasonic cleaning process, performed by a Detrex Sonicleen machine manufactured by the Detrex Corporation of Detroit, reduced poor work in other subsequent operations and made inspection much easier and more thorough.

In the Detrex Sonicleen process, electrical energy is converted into high-frequency sound waves which "scrub" the parts to a degree of cleanliness never before achieved on a production basis.

Using a trough-type barium titanate transducer directly immersed in a degreasing solvent, particle acceleration of 1,500,000 times the force of gravity is achieved in the focal region.

Detrex reports that its Sonicleen process can be applied to nonabsorbent materials such as metals, glassware, and molded products in removing difficult soils.

In addition, the process, as demonstrated at Schick, can replace many hand

develops
a new approach to
SURFACE FINISHING

ROTO-FINISH has now extended the original barrel finishing process to include entirely new special fixture machines and equipment. These machines represent a radically new departure from the generally accepted conception of barrel finishing machines, made possible only by Roto-Finish extensive experimental facilities and long experience with modern, precision surface finishing processes. And these new special fixture machines prove that there are no limits to the size or shape of parts which can be successfully processed with proper equipment, materials and methods.

The new engineering developments which have taken place in the Roto-Finish laboratories open the door wide to entirely new applications and entirely new principles in mechanical surface finishing. Therefore, whatever your finishing problem, we urge you to ship us two finished and several unfinished samples of parts you may wish to have us process in our laboratories. Remember, Roto-Finish guarantees the same result in your shop, as on the samples processed in their laboratories.

Get this new
FREE CIRCULAR

Roto-Finish COMPANY
3703 MILHAM ROAD, KALAMAZOO, MICH.
P. O. Box 988 — Phone 3-5578

It's the finish that counts

brushing or wiping operations to remove soils from cavities, shallow indentations, small holes, and other precision-finished surfaces.

Perfection of the Sonicleen process to meet mass-production requirements was announced by Detrex early in 1953.

Pesco Plating Moves to Brooklyn. Pesco Plating Equipment Corporation and Metal Finishing Manufacturing Company announces their removal from 182 Grand Street, New York, to 89 North 11th Street, Brooklyn, N. Y. The move is being made to consolidate and enlarge their manufacturing facilities.

Mutual Chemical Moves New York Office. Mutual Chemical Company of America has announced the moving of its offices from 270 Madison Avenue to 99 Park Avenue, New York 16. The new telephone number is MUrray Hill 2-3590.

AISE President Calls Steel Industry to Action. "Modernize to survive" may soon be the by-word of the iron and steel industry, according to E. L. Anderson, president of the Association of Iron and Steel Engineers, on the eve of the 1954 Iron and Steel Exposition in Cleveland.

The brisk return of the buyer's market in steel has now reached a point that will force all producers to inspect closely both methods and equipment if competitive survival is to be expected. Millions of dollars worth of equipment has been allowed to become obsolete through the press of war production and later intense consumer demand. Methods possible with out-dated equipment have changed radically and are putting the behind times producer at a disadvantage that could spell ruin without modernization.

Coupled with this, Anderson says, has been a vast development program on the part of mill builders and the suppliers of all types of equipment and materials to the industry. Much of this modern planning and development will be revealed at the Iron and Steel Exposition through the medium of more than 200 exhibits and demonstrations and a series of 16 technical sessions during which 48 technical papers will cover all phases of iron and steel production.

Pennsalt to Build Two New Plants. To provide better customer service for expanding markets for special chemicals, the Pennsylvania Salt Manufacturing Company will add two new plants, George B. Beitzel, president of the consolidated company, has announced. Both plants will serve as major components of the Chemical Specialties Division, which is headed by Albert H. Clem, division president.

New plants will be constructed at Delaware, Ohio, and at Chicago Heights, Ill. The new buildings, which will be constructed by J. C. Breyfogle, industrial

EVEN THE TOUGHEST ACIDS *Shun this Joint*

In acid-proof brick floors — in any type of corrosion-resistant masonry — the joint between the bricks is the critical point. Ordinary mortar joints won't do. Even many specialized "acid-proof" cements will handle only a limited range of acids. Others will handle acids but fail quickly under alkali attack.

But a joint made of Durisite will resist *both* acids and alkalis — will stand up under time, under abrasion, under impact.

Wherever corrosion is a problem you'll find materials and products by U. S. Stoneware on the job. Corrosion specialists since 1865, we work with many materials — with plastics, with rubber, with ceramics, with metals.

U. S. Stoneware's versatile Tygon plastics serve all industry: as clear, flexible hose for piping sensitive fluids, foods, pharmaceuticals, whole blood and blood plasma; as paint to protect concrete and metal surfaces from attack by corrosive fumes; as linings for tanks containing corrosive chemicals. In ceramics, "U.S." white chemical porcelain, and chemical stoneware, are fabricated into large and intricate shapes for chemical plant usage. In rubber—hundreds of specialized compounds meet highly exacting and critical needs. And in the new field of metallic oxides, U. S. Stoneware's ALITE offers solutions to corrosion problems once thought insurmountable.

U.S. PRODUCT OF
STONEWARE
Akron 9, Ohio

The U. S. Stoneware Co. has prepared two booklets which will prove helpful to any company concerned with any type of corrosion-resistant masonry. **"HOW TO BUILD AN ACID-PROOF BRICK FLOOR"** *and* **"CORROSION-RESISTANT MASONRY CONSTRUCTION GUIDE"** *are down-to-earth books with a wealth of pertinent, practical information. They are free, by request on your company letterhead. Write: The U. S. Stoneware Co., Dept. , Akron 9, Ohio.*

375-D

Industry News

contractor-builder of Columbus, Ohio, will be modern, one-story brick structures. These plants will serve as primary regional blending, packaging, warehousing, and distribution centers. The products they will handle include: cleansing and sanitizing agents for the food industries, farm, and home; laundry and dry cleaning chemicals; metal cleaners, coatings, and special lubricants for the metal industries; and maintenance chemicals. Lewis Lye, Pennsalt's oldest product, will be among the products packaged at the Chicago Heights plant.

Roto-Finish Company Expands Laboratory. To facilitate the development of special project machines, the Roto-Finish Company has recently expanded their experimental laboratory facilities. The new laboratory will be devoted to the development and testing of abrasive media and machines designed for special purposes, that is, for finishing parts which ordinarily do not finish well or may not be adapted to finishing with conventional Roto-Finish processes or equipment.

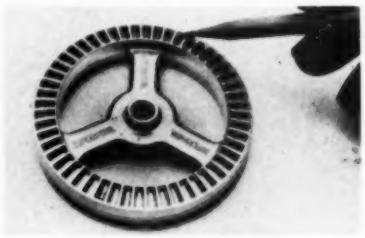
The new types of equipment are particularly useful for processing parts that may be held in special fixtures and oscillated or driven through special grinding media, due either to the kind of material that the parts are made from or to the form or shape of the parts in question.

Metals Distributor to Handle Plastics. Whitehead Metal Products Company of New York, which for 40 years has been a supplier of metal products, is now distributing nonmetal pipe and fittings made of rigid vinyl plastic by Alpha Plastics, Inc., of West Orange, N. J.

The pipe is made in ½ to 4-inch sizes and in molded fittings in ½ to 2-inch sizes. The manufacturer says larger fittings can be made to order. The fittings are threaded or sleeve and are available in tees, 45 or 90-degree elbows, blind flanges, nipples, plugs, companion flanges, couplings, and caps. Valves also are available.

These supplies are made from B. F. Goodrich Chemical Company Geon polyvinyl material—a substance that is not affected by alkalies, acids, salts, oxidizing agents, oils, greases, alcohols, gasoline, and carbon tetrachloride. The distributor says the pipe can be used in the chemical, food processing, gas transmission, and marine industries.

Die-Casting Design Change Simplifies Production of Egg-Beater. A small change in the design of a zinc gear die-casting recently solved a production problem that had been plaguing the Turner and Seymour Manufacturing Company for quite a while. This company markets an egg-beater that utilizes three zinc die-castings: the main frame, the crank, and the driving gear. It was the gear that posed the biggest problem.



In order to impart both sales appeal as well as longer life to the egg-beater, the three die-castings are chrome plated. However, many of the cast gears were not entirely free of surface blemishes, which meant that Turner and Seymour had to spend excessive time in plating and polishing them. Production costs were too high.

When this gear and the problem it posed were first brought to Precision-Castings Company's engineers, they suggested that it be slightly redesigned. They pointed out that the shroud encircling the

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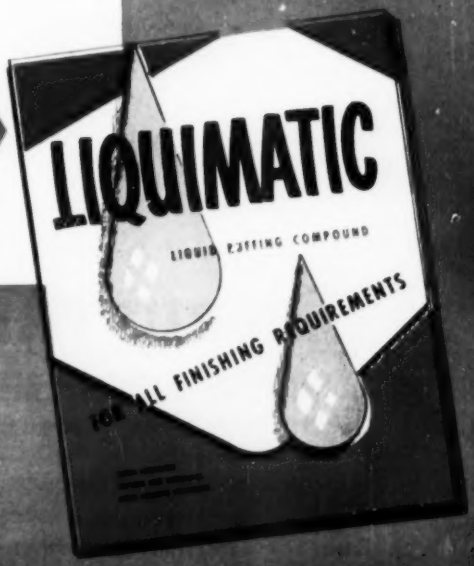

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gear was unnecessarily thin, and this no doubt accounted for the pin holes, the porosity, the heat marks, the cold shot. Some of the zinc apparently solidified before completely penetrating into the thin outer rim, thus preventing its being filled entirely.

Precision Castings Company built different dies, which increased the wall thickness as well as the draft at the ends of gear teeth. Together with better venting and gating practices, these new dies have permitted production rates of acceptable gears to be vastly stepped up. Rejects, despite a highly critical inspection of buffed parts, dropped noticeably.

Finishing operations are handled by Turner and Seymour. After gears and cranks have been electrolytically cleaned, they are rinsed and dipped in acid. The parts are then copper, nickel, and chrome plated, with suitable rinses between the three successive coats. Egg-beater frames are plated in the same manner after first being degreased.

Although the denseness achieved by the new casting methods and special zinc alloy would not normally require mechanical finishing, plated egg-beater parts are polished for maximum beauty and sales potential.

Solventol Licenses British Firm. Solventol Chemical Products, Inc., has announced that the Electro Chemical Engineering Company, Ltd., Weybridge, Surrey, England, has been licensed to manufacture Solventol Di-Phase cleaners and cleaning equipment under the Solventol patents. They will have exclusive sales rights for Solventol cleaners and cleaning equipment in the British Empire and all continental Europe outside the Iron Curtain.

Barrel Finishing Featured at Exhibit. Demonstrations of what can be accomplished by precision barrel finishing were featured at an exhibit by the Lord Chemical Corporation of York, Pa., at the first annual Pennsylvania Industrial and Construction Exposition held in Harrisburg the week of September 20.

Sponsored as a public service by the Keystone Building Contractors Association in cooperation with the Pennsylvania Department of Commerce, the mammoth showing of "Pennsylvania on Parade" was staged in Harrisburg's huge Farm Show Building.

The Lord Chemical Corporation exhibited 20 pieces of tumbling compounds and samples of tumbled work in steel and steel alloys and copper and copper alloys. These were shown before tumbling and after tumbling. In addition, the firm showed its small Lorco 100 Bench Tumbling Barrel. This piece was also displayed with

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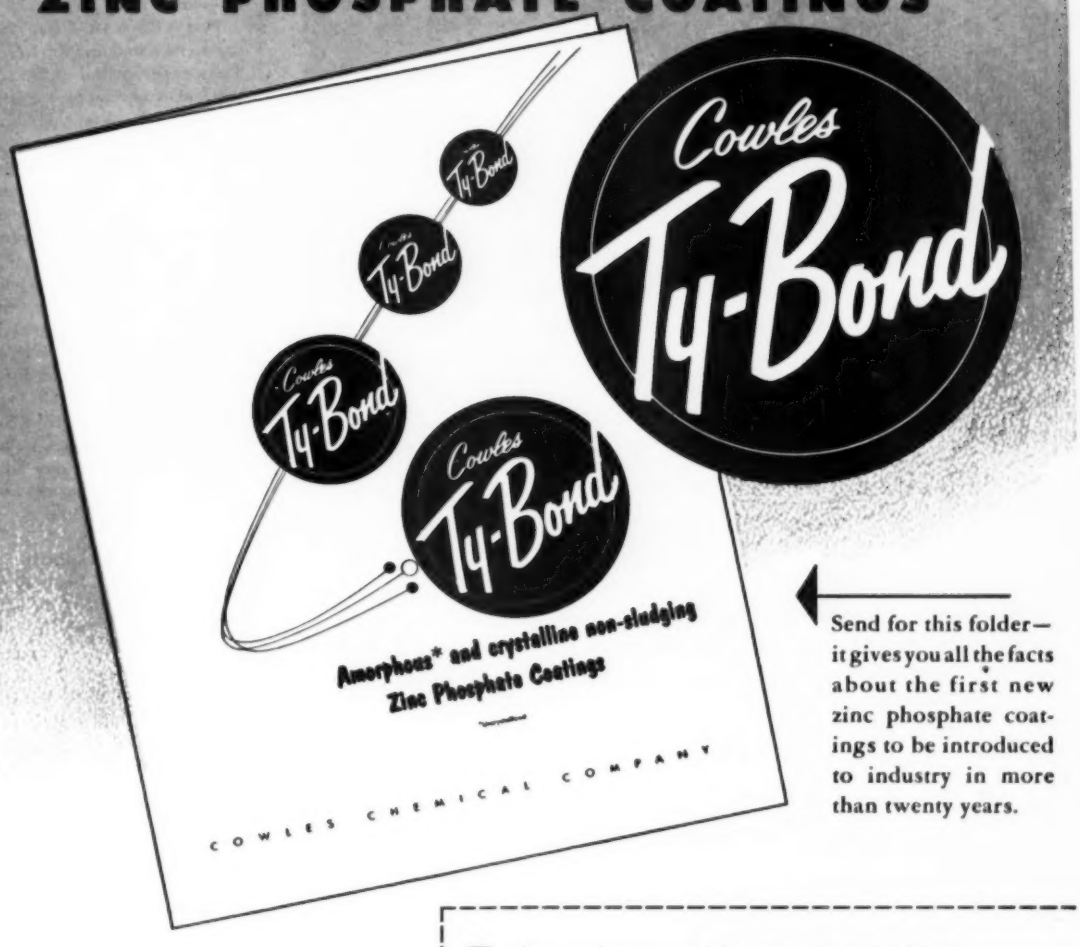

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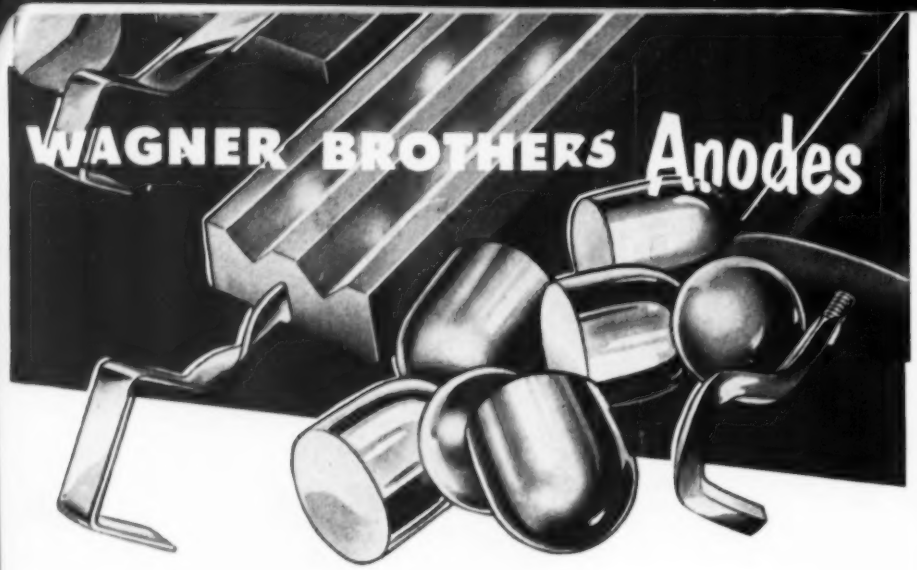

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Industry News

a plexiglas drum to allow visitors to see the action of the materials when the barrel was in motion.

DuPont Plans New Electrochemical Laboratory. Plans for the construction of a $2,550,000 laboratory building at Wilmington, Del., for long-range and fundamental research by DuPont's electrochemicals and pigments departments have been announced by the company. Facilities for each department will be provided in separate wings of the building, which is being shared for reasons of economy.

It was the second new laboratory building to be scheduled for erection at the Du Pont experimental station since a $30,000,000 expansion program was completed there a little more than three years ago. Last June the company disclosed it would build a $1,275,000 laboratory at the station for film department research. Work on this building is now under way.

The latest laboratory project will provide about 50 scientists of the pigments and electrochemicals departments with additional space and the newest in facilities for the kinds of research that in the past have led to the development of new products and new industries.

Some research of this type now being conducted at the electrochemicals department plant at Niagara Falls, N. Y., will be transferred to the new laboratory, thus making available space needed for research at Niagara Falls.

Stevens of Canada Buys Roto-Finish of Canada. Frederic B. Stevens of Canada, Ltd., has purchased the Roto-Finish Company of Canada, Ltd., including manufacturing plants and complete inventory.

The complete Roto-Finish line of metal finishing tumbling equipment, processes, and supplies will be stocked in the Stevens Toronto warehouse and the recently enlarged Windsor warehouse for rapid delivery to all parts of Canada.

National Carbon Offers Free Course. A free two-year course in motor and generator maintenance is being offered by National Carbon Company, a division of Union Carbide and Carbon Corporation. Known as the *National Brush Digest*, this series of pamphlets will be available to electrical and maintenance supervisors and operating men.

Based on National Carbon's 70-year experience in brush theory and manufacture, these pamphlets, to be issued every second month for two years, are specially edited for the operating man. The installments are short, easy to read, and clearly illustrated to hold his interest. Saved for reference, the pamphlets are a handy source of information on many practical

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Bush Yoke Sander manufactured and sold by
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Bush Yoke Sander, wall mounted. The sander arm can be located at five alternative positions from horizontal to vertical.

The same machine, floor mounted. Available with or without the table shown. Belt change is a matter of seconds on this machine.

Smart set-up for polishing small contours

THE BUSH YOKE SANDER is just right for putting the vital mirror finish on the inside contours of jet blades, as in the photo above. The workpoint — belt and contact wheel — can be adjusted to any position required by the operator. This is just one more of the many fine production machines being constantly developed to take full advantage of BEHR-MANNING® Abrasive Belt versatility. Most of these are shown in your nearby BEHR-MANNING Demonstration Room, where you can try them out on your own work. Just phone your local BEHR-MANNING Representative or write Behr-Manning, Troy, N. Y., Dept. PL-10

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Address your requests to National Carbon Company, a division of Union Carbide and Carbon Corporation, 30 East 42nd Street, Room 1328, New York 17, New York, mentioning PLATING.

Precleaning in Tumbling Barrels. A variation of the Emulso-Dip method of precleaning metal parts prior to electrocleaning has recently been reported.

In the Emulso-Dip cleaning method, developed by the Magnus Chemical Company, Garwood, N. J., parts are dipped in (or sprayed with) a cleaning solution made up of one part Magnusol concentrate and eight parts kerosene or safety solvent. This solution penetrates rapidly into oily, greasy deposits, loosens their bond to the metal, and puts them into condition for complete removal when the work is subsequently sprayed with a pressure stream of water. The heavy emulsion formed when the Magnusol solution mixes with water carries off all the dirt, including metal particles and solid dirts that are not removed by conventional degreasing methods.

The variation in procedure was developed in a large job plating concern, which faced a two-shift, five-day week cleaning operation on steel transformer cases, ranging in size from 2 x 2 x 3 feet to 8 x 8 x 10 feet. These cases have to be tinplated ultimately, and the precleaning operation is necessary to put them in proper condition for electrocleaning before plating. They are received in very dirty condition, full of drawing compound, and with considerable rust and heat-treating scale.

The unusual feature of the operation is the use of tumbling barrels instead of cleaning tanks. Two horizontal tumbling barrels are mounted, each above a 70-gallon solution tank. One tank contains the Magnusol solution, unheated. The other tank contains a solution of Magnus D-Scale-R for the subsequent removal of rust and heat scale, after the precleaning operation.

The dirty cases are loaded into the first tumbling barrel, and the Magnusol solution is pumped from the tank below into the barrel until the solution comes up to the level of the loading doors. The barrel is then covered and rotated at about 35 rpm for 20 minutes. At the end of this period the barrel is drained into the solution tank, and the cases, after dumping on screening for adequate draining, are flushed off with a pressure water spray at tap temperature before loading into the second barrel. The cases are open at one end and have an opening at the other end for easy draining.

Except for rust and heat-treating scale, the cases are completely clean of drawing compound, oil, grease, and embedded metal particles. The next stage removes the scale and rust.

For this purpose, Magnus D-Scale-R is used. This is an inhibited acid cleaner that attacks rust and scale, but is harmless to the metal itself. The solution tank for D-Scale-R is made up of 8 ounces of D-Scale-R per gallon of water and heated to 160° F. Precleaned cases are loaded into the second barrel, the solution is pumped in, and the covered barrel rotated for 30 minutes. At the end of this period the cases are rinsed with water after the barrel has been drained back into the solution tank and the drained units have been removed from the barrel. The next step is the electrocleaning operation, in which the transformer cases, completely free of rust and scale, are cleaned in a chemically clean condition prior to tin plating.

The Magnusol cleaning solution is used for weeks without make-up. In the D-Scale-R tank, a small amount of the cleaner is used as make-up once a week, for three weeks, after which a new solution is made up.

Now it can be done!

Eliminates setting switches during loading and unloading of tanks
Removes the possibility of "burning" small loads
Automatically checks if work is added or removed
Plates all work at the proper current
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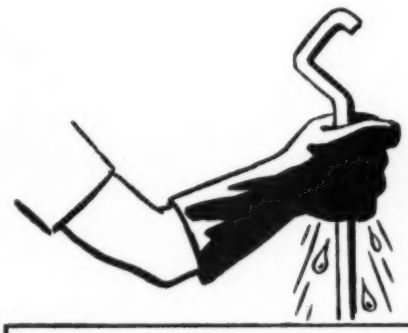

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For brilliant zinc plating —without bright dipping!

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- Blue-white, rust-resistant deposits—over a wide range of current density—obtained *directly* from bath!
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- Particularly effective for barrel plating.
- Work of all shapes and sizes and most ferrous metals can be efficiently zinc-plated.

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Personals

Ranald M. (Don) Garrison has been appointed manager of manufacturing by Hanson-Van Winkle-Munning Company,

Garrison

Matawan, N. J., manufacturers of electroplating and polishing equipment and supplies.

Garrison brings to the company a broad background of manufacturing experience. This includes design and development work in the machinery field as well as production supervision.

Prior to naval service during World War II, Garrison worked for nine years as chief engineer and then plant manager of an oil field equipment company. He has bachelor's degrees in electrical and mechanical engineering, the first from Rice Institute and the second from Cornell University.

Richard C. Goebner has joined the staff of the Pennsylvania Salt Manufacturing Company, Philadelphia, Pa., as a sales trainee in the Metal Processing Department. He will replace **Mal Pancoast,** who is transferring to field training. Announcement of the staff changes was made by **Joseph J. Duffy, Jr.,** Metal Processing Sales Manager.

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B. J. Riggs has been appointed general traffic manager of Behr-Manning Corporation, Troy, N. Y. He succeeds **Harry N. VanAntwerp,** who is retiring after 4 years of service to the corporation.

Riggs

Since 1952 Riggs has been in traffic management, preceded by service as coordinator of defense activities during the recent Korean conflict and production control manager of the electro-textile division. He came to Behr-Manning in 1949 from the D. B. Riggs Construction Company.

Riggs is a founder member of the American Society of Traffic and Transportation and is an active member of the New York Traffic Club, Delta Nu Alpha transportation fraternity, the National Industrial Traffic League, and the American Ordnance Association. He serves on the Transportation Council of Associated Industries of New York.

A native of Troy, Riggs holds a B.S. degree in business administration from Syracuse University and has taken special studies in traffic, contract negotiation, labor relations, and special construction and engineering subjects at Rensselaer Polytechnic Institute, Russel Sage College, and John Huntington Polytechnic Institute.

Frank A. McBrearity has been named Philadelphia branch manager of the industrial rubber products division, Raybestos-Manhattan, Inc., succeeding **G. R. Van Duser.**

McBrearity was central New York sales representative and has served for 19 years in important sales capacities. He will make his headquarters in the Suburban Station Building, Philadelphia.

Howard W. Smith succeeds McBrearity as sales representative for the central New York area. Smith has served in various sales capacities in his 13 years with the company.

Robert A. Canning, formerly manager of production engineering, Carboloy department of General Electric Company, has been named manager of quality control.

Canning will be responsible for all quality control and inspection activities carried on in both the Detroit and Edmore, Mich., plants of the department.

Previous to joining Carboloy in 1946, Canning was affiliated with American

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Personals

Steel and Wire Company, Worcester, Mass.; A. F. Holden Company, New Haven, Conn.; and Acme Heat Treating Company, Worcester, Mass.

He holds a B.S. degree in electrochemical engineering from Massachusetts Institute of Technology.

T. R. Gill has been elected president and a director of the General Supply Company and the G. S. Equipment Company, Cleveland.

Gill is also vice-president of the Singleton Company, manufacturer of metal finishing equipment featuring exclusively fusion-welded "H-T Sincolite." He is general manager and a director for all three corporations.

"Tom" Gill is widely known in the chemical processing and metal finishing fields. He is a graduate chemical engineer from Michigan State, a registered professional engineer and a past officer in the Cleveland Branch of American Electroplaters' Society. He began his career at Udylite in Detroit and New York; moved to Lasalco, St. Louis, later to McGean Chemical, Cleveland, and finally to Van der Horst prior to joining General Supply in 1947 as sales manager.

I. Wendell Hamm of Seaford, Del., has been appointed director of manufacturing for the Carborundum Company, according to an announcement by **Clinton F. Robinson,** president of the company.

Formerly chief of Industrial engineering for DuPont's Nylon division in Seaford, Hamm joined the DuPont Company in 1934 as an industrial engineer. He has since been successively promoted, serving as a management engineer and trouble shooter for the company.

A native of Port Washington, N. Y., Hamm attended Bucknell University for one year, transferred to Cornell, and was graduated from that university in 1932 with a degree in mechanical engineering. In 1933 he received his master's degree in mechanical engineering at Cornell.

Alexander Korbelak, formerly editor of PLATING, has joined Sel-Rex Precious Metals, Inc., as sales manager, according to an announcement made by **Morris M. Messing,** president.

Korbelak

A graduate of Tufts College, Korbelak has published a number of technical papers on techniques in electroplating difficult metals and holds several patents on pulsating plating techniques and metal processing. He spent 11 years in the electronics, chemical, and metallurgical departments of Westinghouse Electric Corporation and worked as an electrochemist for Seymour Manufacturing Company.

John C. Harden has joined the industrial sales and service staff of Wyandotte Chemicals Corporation. He will be located in Toronto to serve the metal industries in Ontario on Wyandotte's line of metal cleaners and related products. He will report to the company's Montreal office.

Harden

Following four years with the Royal Canadian Corps of Signals, Harden studied chemical engineering at McMaster University. His metal finishing experience includes: four years on quality control in the electroplating department of Canadian Westinghouse Company, Ltd., one year as foreman of the electroplating and anodizing department of Coulter Copper and Brass Company, Ltd., and for the past year he has been foreman of the electroplating department of Houdaille-Hershey of Canada, Ltd.

Harden is a member of the American

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Manhattan Rubber Linings are the result of over fifty years development by Manhattan engineers to produce the most economical and dependable rubber linings in the industry today. Every Manhattan Lining is made from calendered sheets of natural or synthetic rubber in required thickness to eliminate plating "risks" and stray currents . . . and to give more protection and longer, better service. Every Manhattan Lined Tank is dielectrically tested to 15,000 volts to detect any imperfections. Manhattan's exclusive rubber-to-metal bond insures permanent protection under severest operating conditions.

For economical, dependable linings which meet your most exacting requirements, specify Manhattan Rubber Linings. You get "More Use per Dollar" with Manhattan Rubber Linings in two ways . . . they provide more protection and they last longer . . . proved by records of uninterrupted service of 25 years and more.

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Wallace & Tiernan offers the heat treating and metal finishing industries several types of Sulphur Dioxide Feeders with optional controls for manual, semi-automatic or fully automatic operation. These feeders are adaptable to either the "batch" or "flow-thru" methods of treatment in both large and small plants.

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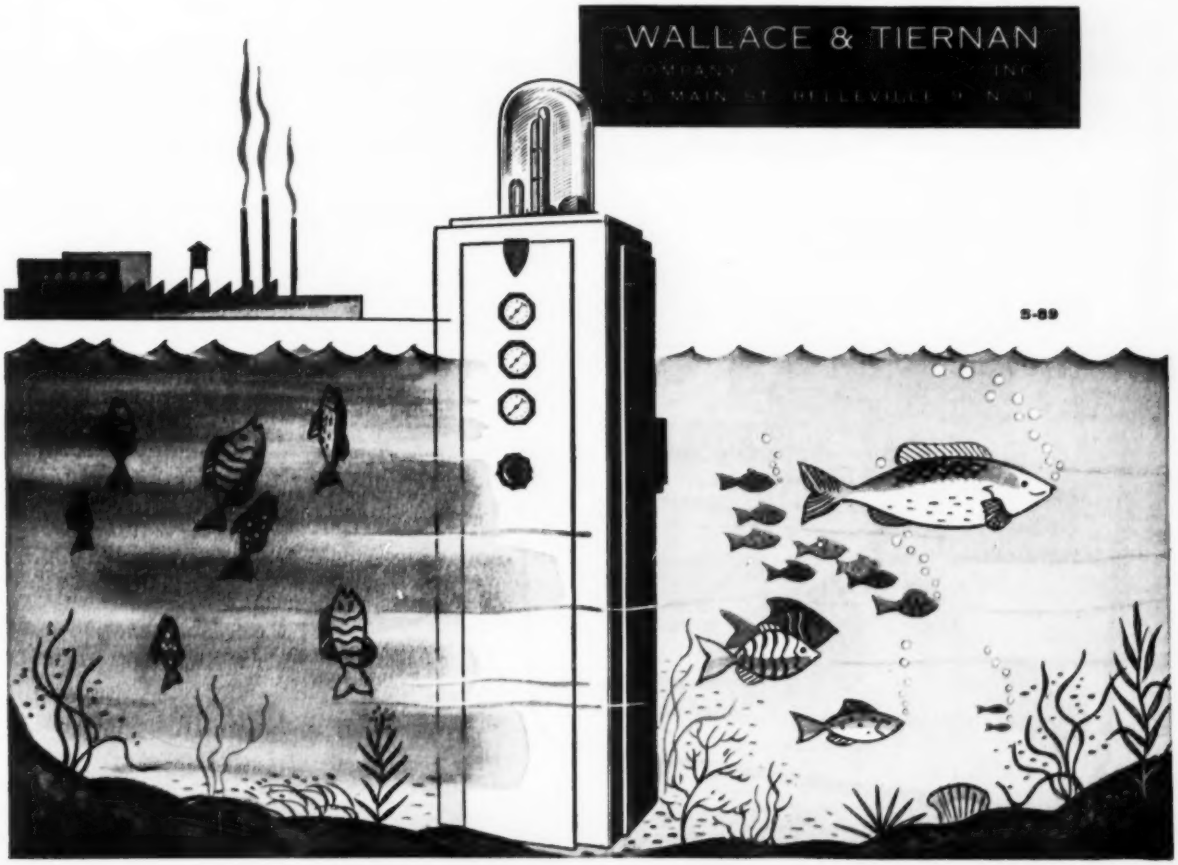
W&T offers PROVEN EQUIPMENT — hundreds of similar units are serving industry today, EXPERIENCE — over forty years of building chemical feeding equipment, and SERVICE — field representatives are located in principal cities throughout the country.

Write today for additional information on W&T Sulphur Dioxide Feeders and Alkaline Chlorination Equipment, at no obligation to you, of course.



Personals

Electroplaters' Society. He has recently been given product application training at Wyandotte Chemicals Corporation's industrial research laboratories.

John Zytell, formerly chief draftsman at Frederic B. Stevens, Inc., has been promoted to engineering of the company's year-and-a-half-old metal finishing waste disposal department.

Zytell

Amis

Duties of the new position will include engineering waste disposal installations, equipment, and layouts; ordering and expediting delivery of component parts; and maintaining liaison with Stevens customers, the Stevens Springfield (Ohio) plant, and Stevens suppliers.

Prior to joining Stevens four years ago, Zytell worked several years in tool and die design, including designing die cast dies, while attending and receiving a tool design certificate from Detroit College of Applied Science. Zytell is a member of the Detroit branch, American Electroplaters' Society.

Robert James Amis has been named chief draftsman of the Frederic B. Stevens, Inc., engineering department by **James Barton,** chief engineer. He fills the vacancy created by the promotion of John Zytell.

Before joining Stevens one and a half years ago, Amis was with A. V. Roe and Company, Ltd., Malton, Ontario, in plant engineering. He helped to make the plant layout for the automatic metal finishing section of Roe's new jet engine plant.

Amis is at present a member of the Detroit branch, American Electroplaters, Society.

George Rieger, of Wilmington, Del., has been named by Diamond Alkali Company, Cleveland, Ohio, to lead and coordinate market research activities of its recently formed commercial development department.

In announcing Rieger's appointment, **C. A. Butler, Jr.,** director of commercial development, said that Rieger will be "primarily responsible for the market research activities for the department—principally projects relating directly to Diamond's continuing diversification and long-term growth."

Rieger will also be engaged in process evaluation studies, economic analyses, and related departmental functions involved in determining the commercial feasibility of new products and the scope of their market potentials.

Rieger comes to the Diamond organization from Hercules Powder Company, Wilmington, Del., where he has been assistant manager of its sales research division since February 1953. From June 1948 to February 1953 Rieger was manager of the applications research division at Hercules' experiment station. His chemical industry experience also includes nearly seven years in various phases of manufacturing and development with the Ethyl corporation.

H. T. Sulcer, vice president and general manager, Graver Water Conditioning Company, division of Graver Tank & Mfg. Co., Inc., New York, has announced the appointment of **Harold R. Fosnot** as sales manager.

Fosnot joined Graver upon graduation from Purdue University in 1935 and became a member of Graver's first training program, which was one of the first of its kind in the industry.

He was previously Chicago district manager, Eastern sales manager, and most recently assistant general sales manager.

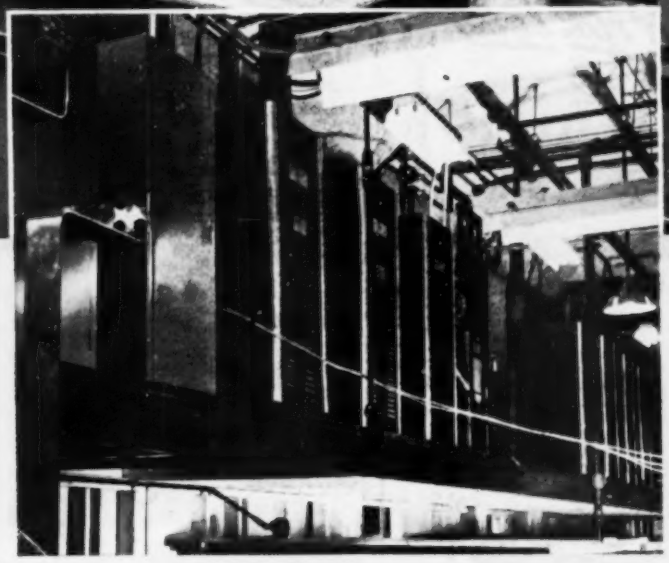
SEL-REX RECTIFIERS

provide the

DEPENDABLE POWER

in this Ultra Modern

PLATING PLANT



Sel-Rex

SELENIUM RECTIFIERS

More than 10,000 amperes of dependable d.c. power, for electroplating valves and other high quality plumbing fixtures, is furnished with Sel-Rex Selenium Rectifiers at the ultra-modern full-automatic Crane Limited plant in Montreal, Canada. Equipment for the entire installation was supplied and installed by Armalite Company Limited, Bart-Messing Corporation manufacturing licensee in Canada.

Sel-Rex Rectifiers afford an efficient and economical power source for every electroplating application because they combine many exclusive design features and are designed and built by plating experts who thoroughly understand the needs of the industry.

Custom designed to provide constant current or voltage . . . variable or fixed output . . . remote or local control . . . Sel-Rex Rectifiers, built in any size up to 50,000 amperes, incorporate all of the most modern engineering and manufacturing developments — represent the highest in quality at a moderate price.

Regardless of your requirements—completely sealed and water cooled rectifiers . . . complete plant lay out and installation . . . plating equipment and supplies — Bart-Messing Corporation offers the most complete and modern service in the electroplating industry.

Write today for your copy of "Plating Power", or have a trained technician call to discuss your specific plating problem.

NEMA

BART-MESSING CORPORATION

Dept. PL-10, 229 Main Street, Belleville 9, N. J.

A COMPLETE RECTIFIER LINE . . . FROM 25 to 50,000 AMPERES

Personals

S. D. Wellen has been named a sales engineer of Bart-Messing Corporation. He will give industry technical assistance

Wellen

in developing diversified uses for Sel-Rex selenium rectifiers, which are presently being used for electroplating, motor controls, battery chargers, aircraft ground power, and testing equipment.

Wellen is a graduate of Stevens Institute of Technology with a mechanical engineering degree and has a master's degree in electrical engineering. Prior to joining the Bart-Messing organization, he was manager of electrical engineering at Heyer Industries, Inc.

John Cook, grinding department foreman, has retired after 43 years with Norton Company, Worcester, Mass. Cook is well known at plants throughout the country for his ability to diagnose grinding problems and for his contributions on better grinding to *Grits and Grinds*, Norton's monthly magazine.

For many years, Cook was a demonstrator and salesman of Norton machines. At one time he served as district manager in the Philadelphia and Syracuse areas. When distributor selling replaced direct selling in those areas, he was returned to Worcester where his years of experience were applied to turning out top quality grinding in Norton's own plant.

Stewart O. Bailey has been named to succeed Cook. Bailey joined Norton in 1937 as an apprentice and has served as a grinder operator, grinding instructor, assistant foreman, and acting general foreman prior to his present appointment.

Charles M. Wellons, formerly a field engineer at the Philadelphia district office, has been named an abrasive engineer and will be responsible for the Philadelphia territory formerly handled by the late **A. Watson Gough.**

Robert C. Divoll, formerly a field engineer in Pittsburgh, has been appointed an abrasive engineer responsible for part of the Pittsburgh territory.

Charles R. Garfield, a recent graduate of the Norton sales training course, has been appointed a field engineer at the Pittsburgh district office.

William J. Mahan has been named field engineer for abrasive grain applications in New England (except for Connecticut) and upper New York State.

Joseph F. Hartl, formerly abrasive grain engineer for all of New England and upper New York State, has been appointed sales engineer, abrasive grain, for Connecticut.

Paul A. Finn recently joined the industrial sales and service staff of Wyandotte Chemicals Corporation, manufacturers of specialized cleaners for the petroleum and

Finn

metal processing industries. He will work from the Dallas office, with headquarters in Houston, and will specialize in petroleum maintenance service.

Finn is a member of the American Petroleum Institute, American Electroplaters' Society, Society of Automotive Engineers, and the American Society of Mechanical Engineers.

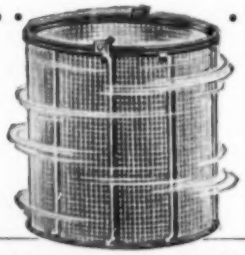
Francis B. Bryant has been named representative in Iowa and portions of adjacent states by Allied Research Products, Inc., manufacturers of the Iridite line of chromate conversion coatings for nonferrous metals and ARP plating chemicals. Bryant will make his headquarters at Bettendorf, Iowa, and will report to **A. L. Poe,** district sales manager, 20 East Jackson Blvd., Chicago.

DRIES SMALL PARTS *Faster–Better..*

DOES IT FOR LESS!

Kreider Dryer with auxiliary gas heating unit (illustrated). Auxiliary steam heating unit available; also standard model without auxiliary heating.

Basket (shown below). Heavy gauge steel woven mesh over steel frame. Capacity, 1140 cu. ins.



Spin-Dries* up to 50 pounds in less than 2 minutes

Simple design . . . careful engineering, sturdy construction assure trouble-free, low-cost maintenance operation. Operates at 625 r.p.m. on less than 1 h.p.

No scarring or marring . . . with Kreider Dryer. Centrifugal force holds parts immovable in basket . . . assures smooth, evenly dried surfaces, long-lasting luster, minimum "rejects".

One man runs it! Standard model Kreider Dryer occupies less than 6 sq. ft. floor space. One man tends—loads, unloads—keeps production moving, prevents expensive, time-wasting tie-ups.

See for yourself! Write Dept. PL 1054 today for illustrated 4-page folder . . . also addresses of installations near you.

New Holland Machine Co., New Holland, Pa.

***Only 2 simple steps required . . .**

(1) Operator places wire mesh basketful of small parts in Dryer . . . turns motor "ON."

(2) Operator turns motor "OFF" . . . presses foot brake . . . removes basket.

NEW HOLLAND *KREIDER* DRYER

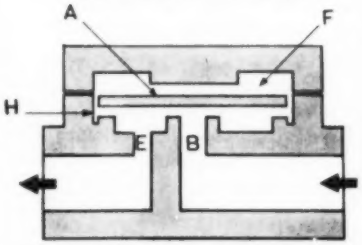
SARCO
Thermodynamic
STEAM TRAP

ACTUAL SIZE

this new trap virtually eliminates maintenance

SOLID STAINLESS STEEL DISC ACTS AS VALVE HEAD

HERE'S HOW IT WORKS!



Air and/or condensate raise valve seat disc A, discharge thru E. When steam follows, greater velocity causes it to strike body at H thus building up pressure in chamber F. This causes disc to seat, closing tube B. As pressure in F decreases by condensation, pressure in tube B raises disc and cycle is repeated.

The Sarco Thermodynamic Trap has proved successful on steam mains and separators; headers and soot blower pipes; engine and turbine stop valves, separators and casing drains; alternate heating and cooling applications.

2098-B

A solid stainless steel disc—practically indestructible—is the only moving part!

MOST striking feature of the Sarco *Thermodynamic* Trap is its simple maintenance-free design. There's only one moving part—a solid stainless steel disc that practically lasts forever. There are no other moving parts to wear out or cause trouble.

Condensate, air and steam act directly on the disc valve which opens to discharge condensate and air—snaps shut to contain steam. There are no mechanical devices required to operate valve (see diagram at left). That means practically endless trouble-free operation.

Other advantages: small size, easy installation, not affected by shock or vibration, immunity to corrosive elements with all wearing parts stainless steel, same valve head and seat for all pressures to 600 psi and temperatures to 950° F.

Check these advantages to your own satisfaction at absolutely no cost. We'll send you a trap for trial. All you do is fill out the coupon and mail it in.

SARCO COMPANY, Inc.
Empire State Building, New York 1, N.Y.

MAIL COUPON TODAY FOR TRIAL

Sarco Company, Inc., Empire State Bldg., New York 1, N.Y.
Gentlemen: Please send me a Sarco Thermodynamic Trap for a 60-day trial, requirements as checked.
Size: ½"... ¾"... 1"... Operating Pressure:.....psi

For installation on.....

NAME_____

FIRM_____

ADDRESS_____

CITY_____ STATE_____

Trade Literature

L—1000 Centrifugal Dryer Brochure—A four-page brochure describing the Nobles centrifugal dryer has been issued by the Nobles Engineering and Manufacturing Company, St. Paul, Minn. In the Nobles dryer, a suction fan draws the air from the bottom; fresh air rushes in from the top to fill the vacuum and is drawn through the entire contents from top to bottom. For your copy, use Reader Service Card.

L—1001. Mechanical Finishing Bulletin—Hanson-Van Winkle-Munning Company offers a new four-page, two-color bulletin that describes products and equipment used for mechanical metal finishing. Items covered in the bulletin can fulfill every requirement for operations in this field.

The bulletin lists H-VW-M's line of standard buffs, compositions, sisal buffs, brushes, polishing wheels, polishing and buffing lathes, and miscellaneous equipment and accessories. Features in the bulletin are the H-VW-M Ruff-L-Buff, designed for fast cutting and cool operation; Acme greaseless compositions, used for either polishing, deburring, or satin finishing; and the Bias Sisalweev buff, which is made for heavy cutting down of either drawn, stamped, or cast ferrous and nonferrous surfaces.

Literature references are included for all products and equipment so a reader will know where to obtain complete details. The bulletin thus serves as a handy index on the entire line of H-VW-M mechanical metal finishing products.

For copies of Bulletin MF-100, use Reader Service Card.

L—1002. Stutz Line Catalogue—George A. Stutz Manufacturing Company has announced a new complete barrel plating equipment catalogue for 1955. The line includes heavy duty production barrels, single and multiple plating units, cylinder loading and unloading stands, alkali cleaning and rinsing units, and portable plating barrels featuring a new design. Power conversion equipment is also included.

You can obtain your copy by using the Reader Service Card.

L—1003. Circular on Floor Absorbent Use—A new circular describing the use of Zorball, an all-purpose floor absorbent, by more than 20 different industries has just been released by Wyandotte Chemicals Corporation. Of particular interest to all who have slippery floors to combat is the fact that even oil or grease saturated Zorball resists burning.

Circular 655 may be secured by using Reader Service Card.

L—1004. Diamond Grinding Wheel Catalogue—A new catalogue, No. 1233, containing a comprehensive assortment of standard sizes of diamond grinding wheels and hones, has just been published by Norton Company. Included in the tables of this 52-page booklet is the net price to the customer of each item listed, in various ordering quantities.

The booklet also includes information on diamond wheel markings, selection of wheels, standard shapes of wheels, and suggestions on the use of diamond wheels and hones.

For your copy, use Reader Service Card.

L—1005. Survey Shows Fire Hazards in Metalworking—In recent years the metalworking industries have been beset by fire. Since 1942 large-loss fires in both heavy and light metalworking plants have increased 17 times. This is due in part to higher concentration of values in buildings, equipment, and products exposed to fire and hazardous new auxiliary processes and mixed occupancies.

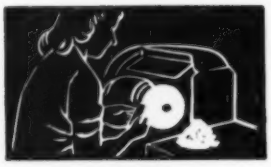
These facts are brought out in a 57-page survey on fire hazards and safeguards for metalworking industries issued recently by the National Board of Fire Underwriters.

Only PARAMOUNT Felt Wheels do so many finishing jobs so well

Just 1 PARAMOUNT Wheel does all three:

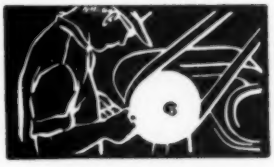
BUFFING

Choose a Paramount Felt Wheel for your highlight buffing and enjoy finishes produced to **your** specifications . . . and get longer trouble-free service from your wheel too! Or use the **same** wheel for —



POLISHING

Set up your wheel with abrasive grains (120-320 grit) for streakless polishing or with greaseless compounds for satin finishes. Or use your wheel as a —



CONTACT WHEEL

Whether you're using belts for polishing or finishing, the wide range of sizes and densities of Paramount Felt Wheels make them ideal for your most exacting work.

Learn what the versatility of Paramount Brand Wheels can mean to your work and your finishing costs. Call your Supply House today for details.

New Catalog Answers your questions about felt wheels

Just off the press — a new 12-page catalog crammed with authoritative finishing information. Send for your free copy today.

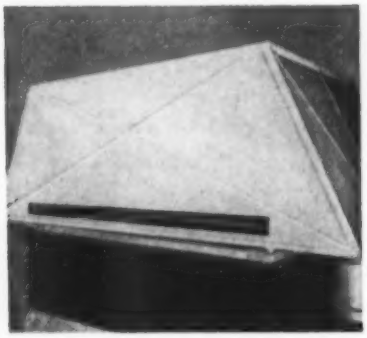
Bacon Felt Company

407 WEST WATER STREET • TAUNTON • MASSACHUSETTS

Established 1825 "Felt Does It Better"

from jet age research
16
PROSEAL
odern, low cost and PERMANENT protection
for ALUMINUM and its alloys
Here's a new chromate film that draws on an entirely new concept of protective value . . . to bring the economy and efficiency of mass production to the surface protective treatment of aluminum and its alloys.
A chemical process, Proseal #16 can be quickly applied, at a fraction of the cost of anodizing. "Prosealing" treatment time is short, equipment needs simple and inexpensive. A high ratio of (insoluble) trivalent chrome assures long protective life . . . a proven barrier to corrosive action that can withstand hundreds of hours in accelerated salt spray fog tests.
Accepted for requirements specified in MIL C 5541, Proseal #16 can bring exacting military aircraft standards to applications where extruded, forged, wrought or cast aluminum require modern protection.
Write today for further details on Proseal #16 . . . another product of original research by PROMAT.
PROMAT Division
POOR & COMPANY
851 S. Market Street
Waukegan, Illinois

THIS PLA-TANK® HOOD SAVED ITS COST IN A YEAR



The PLA-TANK Hood shown above has been in continuous use at General Electric's small aircraft engine department in West Lynn, Mass., for over a year. Reports indicate that it is still as good as when originally installed, is already credited with saving its entire cost since no previously used material had lasted over a year.

The tank is used for etching stainless steel billets; solutions used are aqua regia at room temperature and a 50% solution of muriatic acid at 180°F. PLA-TANK has successfully withstood these fumes, where other materials failed.

PLA-TANK products are daily solving problems of all types in the chemical and electroplating fields. They replace or outlast stainless steel, lead and ceramic linings, plywood coated with corrosion preventatives, phenolic plastics and asbestos cement board structures in many applications.

PLA-TANK, molded from long-life, resin-bonded glass fibre laminate, is now resistant to a wider variety of fumes and temperatures than ever before. PLA-TANK is light weight, easy to install, competitively priced.

Let us help you solve your problems the modern way — with PLA-TANK. Write today for free data sheets.

P-21

THE Chemical CORPORATION

57 Waltham Ave., Springfield 9, Mass.

Trade Literature

According to the National Board, there were about 175 large-loss fires—those that result in damage of $250,000 or more—in the metalworking industries between 1942 and 1953, with an aggregate loss of approximately $150,000,000 as contrasted with the period from 1931 to 1942, when only 18 large-loss fires were reported with aggregate losses of $8,500,000.

The survey points out that many new factors have entered the fire safety picture in recent years. But more important is the presence of old fire causes in a more pronounced form. These are large unprotected areas, the use of woodwork and plastic materials in fabrication processes, as well as the use of flammable liquids.

To receive a copy of this survey, "Fire Hazards in the Metalworking Industries," use Reader Service Card.

L—1006. Stevens Laboratory-Verified Reports Bulletin—A 16-page bulletin featuring the Stevens L.V. (Laboratory Verified) reports and how they can be used to aid metal finishing job shops or the metal finishing department in larger plants has just been released by Frederic B. Stevens, Inc., Detroit.

This new bulletin differs from previous catalogues in that it presents more than a list of polishing and buffing compositions regularly available. It features the Stevens L.V. report and explains how similar cost-cutting reports can be obtained for any plant metal finishing problem.

One section is devoted to "How Stevens L.V. Reports Helped Others," a list of successfully solved metal finishing problems; and "How to Test Buffing Compositions in the Plant: Stevens L.V. Composition Recommendations for Plated Surfaces; Stevens L.V. Composition Recommendations for Unplated Surfaces; Automatic Buffing Requirements."

Copper, nickel, stainless steel, and plastic buffing are also covered, plus a section devoted to liquid compositions.

Of particular value to many metal finishing superintendents and foremen is an index to treatment of materials at the back of the bulletin.

Copies of this booklet may be obtained by using the Reader Service Card.

L—1007. Rectifier Catalog—Crown Chemical and Engineering Company, Los Angeles, manufacturers of selenium rectifiers for electrochemical industry, has recently published a new bulletin, describing in considerable detail the various types of rectifiers manufactured by Crown, as well as applications for each particular type.

Crown's engineering staff were pioneers in the development of magnetic amplifier control for plating and metal finishing operations. This new bulletin outlines the newest developments in this field. For more information, use Reader Service Card.

L—1008. New pH Bulletin—A new bulletin on complete instrumentation for *p*H measurement and automatic control has been published by the Bristol Company of Waterbury, Conn.

It contains drawings and photos of installations of *p*H recording and controlling instruments on specific processes in the drug, chemical, food, rubber, petroleum, pulp and paper, textile, water treatment, sewage disposal, and metals fields, as well as detailed drawings on different methods of installing the various instruments for *p*H measurement.

The bulletin features complete *p*H systems, including the electrode assemblies, amplifier, and Electronic Dynamaster round-chart or strip-chart recorders and controllers in both pneumatic or electric control actions. The new Beckman Model W Amplifier is illustrated and detailed for the first time in conjunction with a *p*H recording and controlling system.

Accessories shown in the bulletin include: electrodes and assemblies, manual and automatic multiple switching stations for recording *p*H measurements from more than one point with a single Multiple-Record Dynamaster; connector boxes for use where it is necessary to offset the amplifier more than 10 feet from the electrodes; and a complete line of final control elements for adding liquid, solid, slurried, and gaseous reagents to the process. Illustrated with 100 photos and detail line drawings, the 38-page bulletin Q1304 is now available; use Reader Service Card.

L—1009. Facts About Zirconium—The Carborundum Metals Company, Inc., Akron, New York, was organized for the dual purpose of supplying AEC and industry with zirconium metal suitable for their specific applications. At the same time, it was planned to supplement the production of metal with those zirconium chemicals for application in the chemical industry that would easily and logically fit into the operations. Work has gone along according to schedule and now, in addition to its AEC commitments, Carborundum Metals is producing zirconium metal and other related products for commercial applications.

Demand for information about zirconium has been so great that the Carborundum Metals Company recently published a booklet, "Facts About Zirconium," for general distribution.

"Facts About Zirconium" is a concise compilation of information about the history and production of zirconium. The mechanical and physical properties, chemical properties, and facts about fabrication of zirconium such as melting, forging, rolling, welding, and machinability are discussed. One chapter treats of zirconium

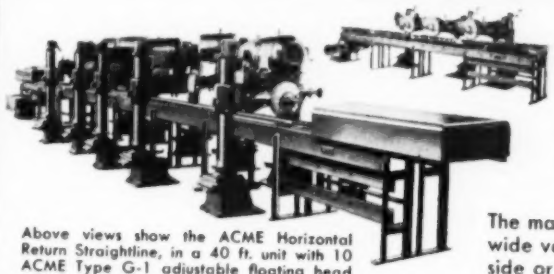
ACME *Automatics* PUT POLISHING *and* BUFFING OPERATIONS *on a low cost production basis . . .*

ACME *Semi-Automatics*

ACME Semi-Automatics are built to "deliver the goods." They can be fully relied upon to cut finishing costs, maintain production levels and stand up under long hours of operation!

The three ACME Semi-Automatics above are from left to right, the ACME A-2, a 2 spindle hand indexing machine for polishing and buffing cylindrical parts up to 12" diameter . . . the ACME L-4, a 4 spindle automatic indexing machine with a normal range of 250 to 400 indexes per hour . . . and the ACME D-10, an oscillating machine for finishing out of round parts. These machines are proved producers.

WRITE FOR CATALOG ILLUSTRATING WIDE RANGE OF TYPES



Above views show the ACME Horizontal Return Straightline, in a 40 ft. unit with 10 ACME Type G-1 adjustable floating head polishing and buffing lathes . . . and a 20 ft. unit with 3 ACME Type G-3 lathes.

ACME *Straight Lines*

ACME Straightlines provide effective solutions to many finishing problems. ACME progressive experience and engineering assure dependable performance at high production levels.

The machine illustrated is unusually versatile and adaptable to a wide variety of work. It may be loaded or unloaded from either side or either end. Polishing and buffing heads may be used on either or both sides and may vary in number to suit the required production and finish.

WRITE FOR OUR STRAIGHTLINE CATALOG ILLUSTRATING OTHER TYPES

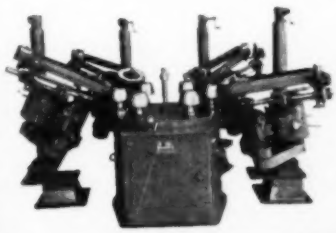
ACME *Rotary Automatics . . .*

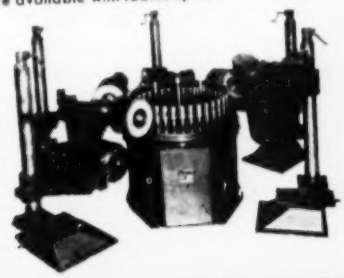
ACME 40" Rotary with 6 station indexing table and 4 ACME Type G-1 lathes with belt arm attachment. One second indexing time . . . up to 1800 indexes per hour. Acme Indexing Rotaries are available in table sizes from 18 in. to 10 ft. diameter.

ACME 10 ft. Combination Rotary . . . for continuous operation using 24 continuously revolving spindles or for 12 station indexing operation using every other spindle. One second indexing time . . . up to 1200 indexes per hour.

ACME 50" Continuous Rotary Automatic with 40 spindles equipped with 4 Acme Type G-3 heavy duty 15 H.P. polishing and buffing lathes with inverted spindles. ACME Continuous Rotaries are available with tables up to 24 ft. diameter.

WRITE FOR ROTARY CATALOG





for POLISHING • BUFFING
GRINDING • MICRO-FINISHING
DE-BURRING • WIRE BRUSHING

SPECIAL MACHINERY — AUTOMATIC BUFFING MACHINES

ACME *Manufacturing Co.*

Builders OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR NEARLY HALF A CENTURY

1400 E. 9 MILE RD., DETROIT 20 (Ferndale) MICH.

need a finish for protection—decoration—identification? specify IRIDITE®

Specify Iridite . . . for corrosion protection during storage or use . . . for a firm and lasting base for paint . . . for extra quality and eye-appeal . . . for low cost color coding of finished parts.

ON ZINC AND CADMIUM you can get highly corrosion resistant finishes to meet any military or civilian specifications and ranging in appearance from olive drab through sparkling bright and dyed colors.

ON COPPER . . . Iridite brightens copper, keeps it tarnish-free; also lets you drastically cut the cost of copper-chrome plating by reducing the need for buffing.

ON ALUMINUM Iridite gives you a choice of natural aluminum, a golden yellow or dye colored finishes. No special racks. No high temperatures. No long immersion. Process in bulk.

ON MAGNESIUM Iridite provides a highly protective film in deepening shades of brown. No boiling, elaborate cleaning or long immersions.

AND IRIDITE IS EASY TO APPLY. Goes on at room temperature by dip, brush or spray. No electrolysis. No special equipment. No exhausts. No specially trained operators. Single dip for basic coatings. Double dip for dye colors. The protective Iridite coating is not a superimposed film, cannot flake, chip or peel.

WANT TO KNOW MORE? We'll gladly treat samples or send you complete data. Write direct or call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified telephone book.

Iridite is approved under government specifications

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD

Manufacturers of Iridite Finishes for Corrosion Protection and Paint Systems on Non-Ferrous Metals, ARP Plating Chemicals.
WEST COAST LICENSEE: L. H. Butcher Co.

Trade Literature

chemicals such as zirconium tetrachloride, dioxide, and sulphate and Carbo-Cast-Aid. The appendix lists various data on zirconium. For a free copy, use Reader Service Card.

L—1010. Germanium Diode Bulletin—A new, four-page "Bulletin GD-1A," listing ratings and specifications on International Rectifier Corporation Germanium Diodes, is now available. Included in this bulletin is a complete replacement guide of International Rectifier Germanium Diodes for replacing Retma-type diodes and ratings and characteristics for new "Red Dot" germanium diodes for 100° C applications. For a free copy, use Reader Service Card.

L—1011. Operation Recorders Bulletin—A new bulletin describing and illustrating the company's line of electrical and mechanical operation recorders, both round-chart and strip-chart models, has just been published by the Bristol Company of Waterbury, Conn.

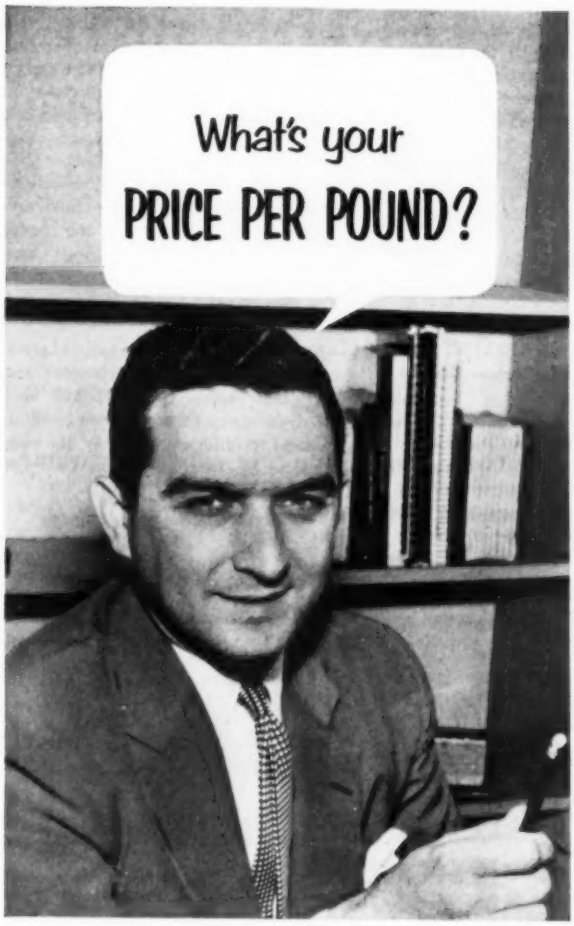
Round-chart electrical operation recorders are designed to furnish a record of the time of occurrence and duration of an operation. The machine or apparatus under observation is equipped to open and close a simple contactor or switch each time an operation occurs. Recorders that will make up to twelve records simultaneously are available. Contactors suitable for service with the recorders are also listed in the bulletin.

Round-chart or strip-chart mechanical operation recorders have a pen arm that travels across a chart in such a way as to provide a record of the time and extent of movement of any object connected to the projecting lever arm or sprocket pulley drive.

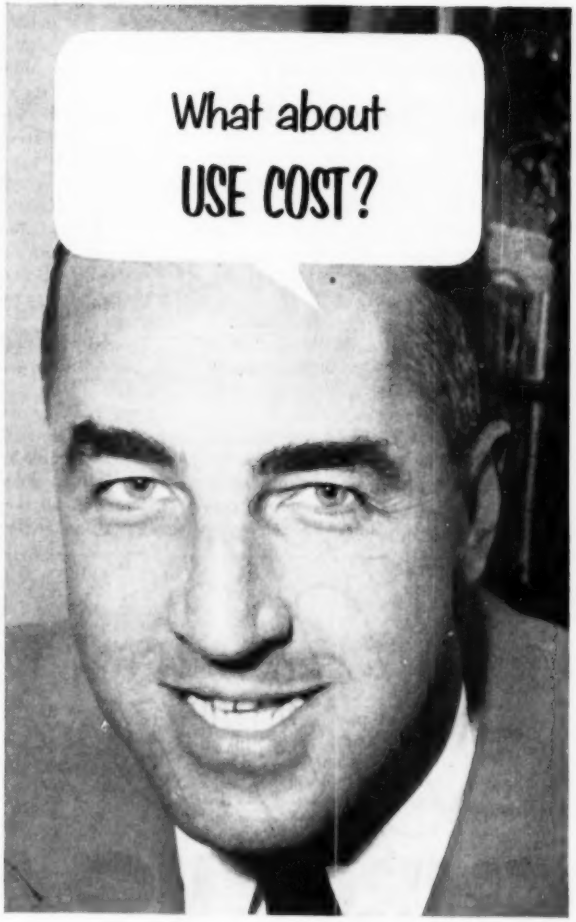
Application of such recorders include batch weighing on platform scales, automatic weighing machines, valve or gate operation, gas holder movement and position, or liquid level variation. Copies of Bulletin OP1505 are available; use Reader Service Card.

L—1012. Liquid Filters Folder—A new four-page illustrated folder describing permanent membrane-type liquid filters has been published by the manufacturer, Wagner Brothers, Inc., Detroit. The literature explains precoating, filtering, and cleaning operations, with schematic drawings showing flow directions during each of these phases.

The folder tells how efficient, low-cost clarification of solutions is made by filtering acid, alkaline, or neutral liquids through a series of permanent membranes (wire well screen, porous stone, or porous carbon), caked with diatomaceous earth, to remove all suspended particles down to 1/10 micron. Secure your free copy by using Reader Service Card.



This man may be a good buyer; he probably gets what he pays for.



But this man is a <u>better</u> buyer; he keeps cleaning <u>costs</u> at rock bottom!

How Do You Buy Cleaning Products? If you want the most value for your money, it will pay you to buy on the basis of performance and "use cost," not "price per pound." Cheap products usually cost *more* in the long run. Wyandotte is a basic producer of high quality, specialized cleaning products for industry. Experienced Wyandotte field men have the products and know-how to make cost-saving suggestions for *your* operations. Mail coupon today! *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Also Los Nietos, California.*

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CHEMICALS

Helpful service representatives in 138 cities in the United States and Canada

WYANDOTTE CHEMICALS CORPORATION
Department 2261, Wyandotte, Michigan

I'm interested in low "use cost" cleaning products. Please have your man call and make cost-saving suggestions.

NAME _____

FIRM _____

ADDRESS _____

CITY _____ ZONE ____ STATE _____

Equipment and Supplies

E—1013. New G. E. Rectifier-Type Welder—A new 300-amp, NEMA-rated, rectifier-type welder featuring quiet operation and low maintenance cost has been announced by the General Electric Company's welding department.

Now in production at the department's new plant at York, Pa., the welder offers full time arc force control for holding very short arcs with deep penetration, according to company engineers.

A current range of 20 to 375 amperes is provided. The new welder utilizes the moving primary coil design, obtaining current adjustments by separation of primary and secondary coils. Stepless current control and highly accurate amperage settings are made possible by this design. Windings are aluminum and silicone insulation is used on all coils.

Cooling for coils and rectifier stacks is provided by forced-draft ventilating fans. Operating on the updraft principle, the fan can be reversed by spring loaded toggle switch to blow dust from the stacks, prolonging their life.

A polarity reversing switch is standard equipment and access for maintenance is simplified due to the unit's removable side covers.

Descriptive publication GEC-1267 may be obtained by using the Reader Service Card.

E—1014. New Tripoli Buffing Compound—Learok Tripoli TP42X is a new, fast cutting, clean working composition for buffing all nonferrous metals. This composition is formulated to give extra bar strength for automatic buffing with mechanical applicators, and operating economies are effected through more work per bar due to the new formulation of the compound. Strength of bar is not affected by elevated temperatures, commonly met with in summer months. Bar sizes are manufactured to specifications in widths of 2 inches or more and any length or shape, according to the manufacturer, the Lea Manufacturing Company.

For samples, use Reader Service Card.

E—1015. Small Parts Cleaner—Development of an automatic carburetor and small parts cleaner that provides mechanical air agitation of solvents to eliminate hand scrubbing completely has been announced by Turco Products, Inc., Los Angeles, Calif.

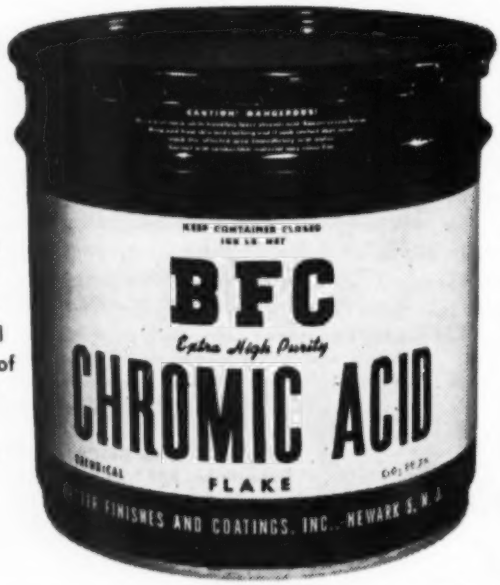
Called the Turco jet-action small parts cleaner, the unit is designed for quick attachment to any air hose. Eight air jets in the 6½ gallon agitator unit set up a turbulence pattern that activates the cleaning solvent so that it penetrates into the smallest cracks or crevices in the parts being cleaned. This controlled turbulence continually flushes the parts as they are cleaned . . . precipitates scale and sediment to the sump in the bottom of the tank.

The compact, portable unit has no moving parts or motors . . . is extremely easy to use. For more information, use Reader Service Card.

E—1016. Oxygen Analyzer by Beckman—The newest addition to the industrial line of instruments manufactured by Arnold O. Beckman, Inc., South Pasadena, California, is the Model 1A3B dissolved oxygen analyzer. This new instrument provides accurate and continuous measurement of dissolved oxygen in such applications as waste disposal, sewage and water treatment plants, manufacture of petroleum products, solvents, chemicals, and a wide range of other operations.

Model 1A3B combines in one unit a simple physical scrubbing mechanism for removing dissolved gases from the liquid being analyzed and a standard Beckman oxygen analyzer for measuring the oxygen

99 75+% PURE
CHROMIC ACID
TECHNICAL GRADE—FLAKE



Ownership-management make the difference! We say exactly what we can do... and then do it without alibis or buck-passing. We think you'll like the uniform quality of BFC Chromic Acid and the single-standard-of-service behind it. When you're in the market, why not telephone us at MArket 3-2663?

BETTER FINISHES & COATINGS, INC.
268 Doremus Avenue, Newark 5, N. J. • 122 East 7th St., Los Angeles 14, Calif.

The BIGGEST Time and Money Savers in Plating Rack History!

Racks for any job when you need them.
No delay—no waiting.

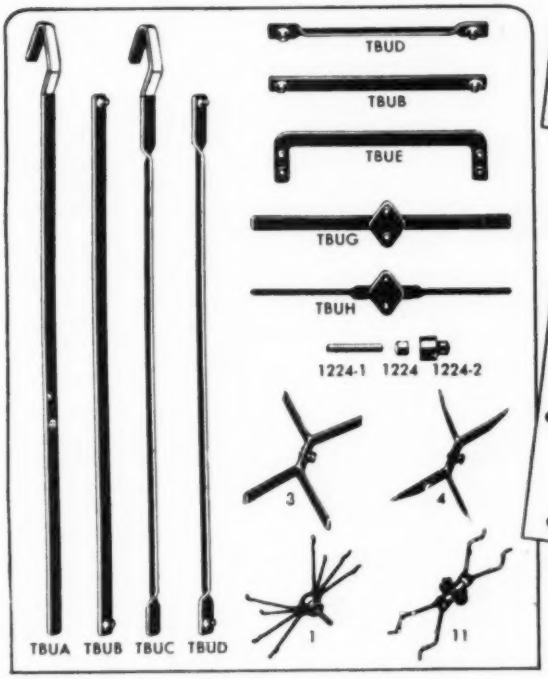
Quick and easy conversion.
Racks easily changed to fit different jobs—you can have top efficiency on every job.

Replaceable Tips for easy tip upkeep.
Enable you to keep every rack at full capacity.

Tremendous saving in plating rack costs.
You can make new racks designed for the job from members of discarded Thinker Boy Racks at the mere cost of assembly.

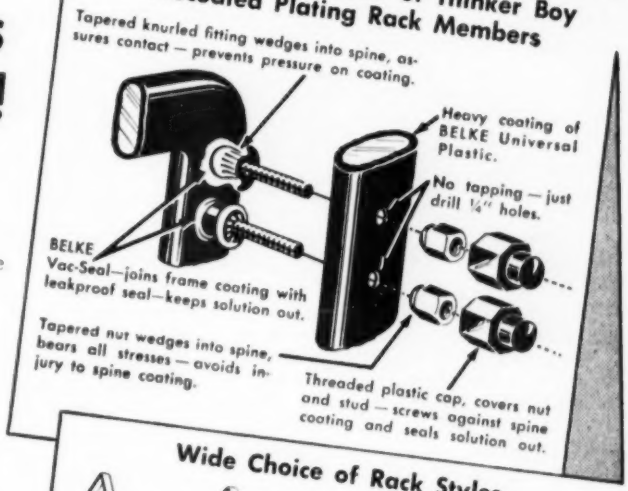
No added investment necessary. *Here's how you can cash in on the tremendous time and money saving economy of Thinker Boy Racks without investing an extra dime.*

1. When you need racks get *Thinker Boys.* Vac-Seal replaceable tips enable you to keep every Thinker Boy Rack at full capacity.
2. When Thinker Boy Racks of one design are no longer needed, convert them to a design you need or disassemble and store the parts.
3. When you need racks for a different job, assemble them from your stock of used Thinker Boy Parts. You get racks designed for the job in a matter of minutes for the mere cost of assembly.

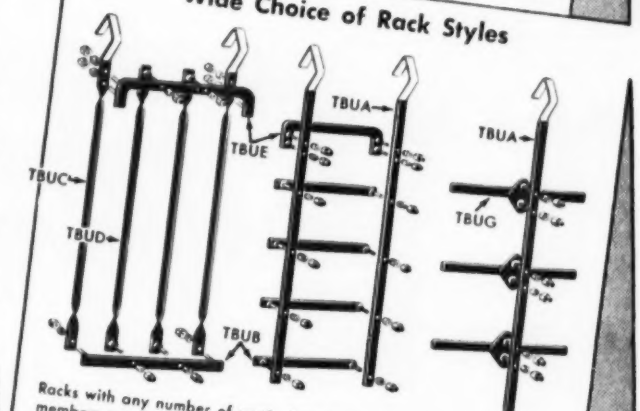


Thinker Boy Precoated Vac-Seal Parts are mass produced for low cost and carried in stock for prompt shipment. Furnished in any assortment or assembled to your specification. Ask your BELKE Service Engineer or write for descriptive bulletin and parts list.

LEAKPROOF ASSEMBLY of Thinker Boy Precoated Plating Rack Members

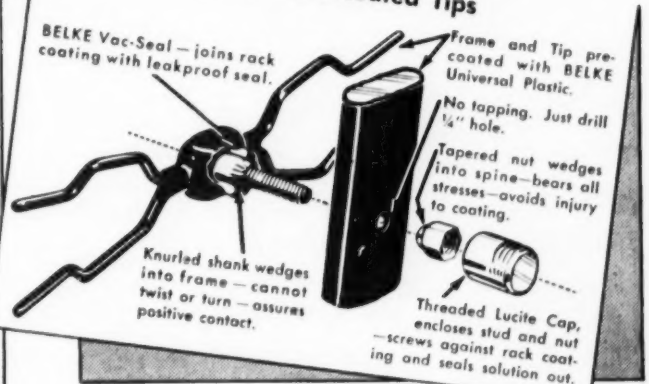

Tapered knurled fitting wedges into spine, assures contact — prevents pressure on coating.
Heavy coating of BELKE Universal Plastic.
No tapping — just drill ¼" holes.
BELKE Vac-Seal—joins frame coating with leakproof seal—keeps solution out.
Tapered nut wedges into spine, bears all stresses — avoids injury to spine coating.
Threaded plastic cap, covers nut and stud — screws against spine coating and seals solution out.

Wide Choice of Rack Styles



Racks with any number of vertical members, horizontal members or T members are quickly assembled from a small selection of Thinker Boy precoated Vac-Seal Parts—¼" drill and pliers are only tools needed.

LEAKPROOF MOUNTING of Vac-Seal Precoated Tips


BELKE Vac-Seal — joins rack coating with leakproof seal.
Frame and Tip precoated with BELKE Universal Plastic.
No tapping. Just drill ¼" hole.
Tapered nut wedges into spine—bears all stresses—avoids injury to coating.
Knurled shank wedges into frame — cannot twist or turn — assures positive contact.
Threaded Lucite Cap, encloses stud and nut —screws against rack coating and seals solution out.

Belke MANUFACTURING CO.
947 N. Cicero Ave.
Chicago 51, Ill.

EVERYTHING FOR PLATING PLANTS

Equipment and Supplies

in the removed gases. This combination provides a highly accurate measuring system for dissolved oxygen.

The instrument is designed to read per cent saturation directly, but scales are also available calibrated in parts per million if desired. Model 1A3B may be used with any standard potentiometer recorder or indicator, thus simplyfying its installation where certain types of recorders are preferred.

Bulletin 113, which describes the many advanced features of the Model 1A3B in greater detail, may be obtained by using Reader Service Card.

E—1017. Bright Nickel Process—A new bright nickel process has recently been developed by Wagner Brothers, Inc., Detroit manufacturers of electroplating equipment and supplies.

The new nickel brightening process is called "Wabrite" and was developed as a result of extensive research at the Wagner Brothers laboratory, working in close collaboration with the research staff of a well-known Midwestern university.

Wabrite allows extremely high tolerances for impurities without impairing the quality of finish. Leveling, hiding, and ductility of Wabrite are claimed to be unmatched by any known process. Excellent throwing power (up to 100 amp/sq ft) permits uniform plate deposition into recesses. In addition, Wabrite furnishes a highly active nickel deposit, for subsequent chromium plating. Conversion of present baths to Wabrite is easily made without loss of nickel bath or primary brightener. For further information, use Reader Service Card.

E—1018. Kocour Selenium Plating Rectifiers—The new Kocour selenium rectifier line meets every D-C plating power supply requirement. These units are hand assembled and include rigidly

pretested components of the highest quality. The heavy-duty liberally designed transformers are multiple coated to resist corrosive atmospheres and humidity. The unit is fan cooled, utilizing a ball bearing polyphase pregreased motor.

All of the Kocour selenium plating rectifiers are housed in an industrial duty, heavy gauge steel cabinet, completely electrowelded, chrome primed, and finished to resist corrosion and humidity. For descriptive literature, use Reader Service Card.

E—1019. Pennsalt Develops Electrocleaner—The Pennsylvania Salt Manufacturing Company, producer of chemical specialties widely used in the electroplating industry, has announced the introduction of a new, heavy-duty electrocleaner known as Pennsalt Cleaner K-8.

Recommended for use on steel and copper, K-8 provides excellent detergent properties with unusual ability to remove mill oil and smut from steel prior to electroplating. This is accomplished through a new concept in the use of surface active agents.

Pennsalt Cleaner K-8 is a granular, anhydrous product containing 100 per cent active ingredients that resist neutralization by acid soils and provides excellent electrical conductivity. It is resistant to the effects of hard water and is free rinsing.

Detailed product information, including recommended cycle and control data, will be furnished on request by using the Reader Service Card.

E—1020. Reclaims Diamond Dust—A new chemical service for industrial users of diamond dust has been announced by the Astra Corporation, Cleveland, Ohio.

The industrial user saves the cloth

BRASS PLATING WITH TRUE BRITE

❶ improve color

❷ save labor

❸ eliminate supervision

❶ *color stays constant . . . no rejects*

❷ *eliminates frequent analyses . . .*

❸ *trouble free . . . only one addition instead of three*

Write for FREE bulletin! Your key to better Brass Plating

Available in regular 3 to 1 ratio for yellow Brass Plating.

Special ratio materials for plating richlow brass or any other desired alloy of copper and zinc.

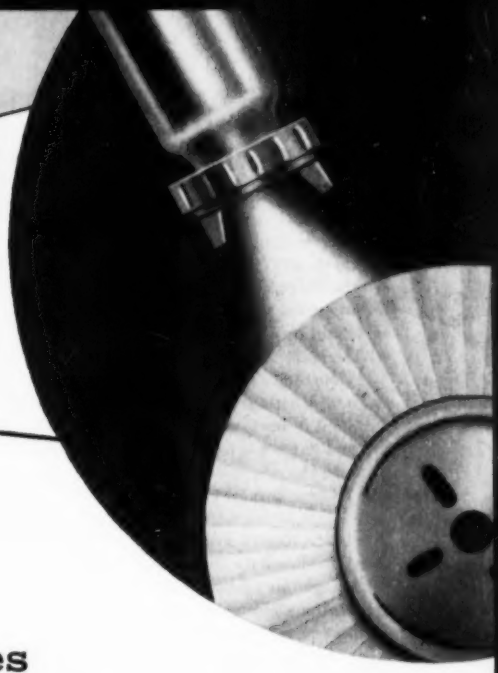
Suitable for both still tanks and barrels.

TRUE BRITE CHEMICAL PRODUCTS CO.

P. O. Box 31, Oakville, Conn.

STUTZ

LIQUISPRAY



BUFFING COMPOUND

Here's why "LIQUISPRAY" saves you money over bar compounds

- No crumbling or nubbins—all the compound goes on the wheel
- Same regulated quantity applied
- No machine downtime to change bars

Here's what "LIQUISPRAY" can mean to you

- Increased operator efficiency
- More uniform finish and fewer rejects
- Compound costs cut up to 50%
- Tremendous increase in buff life

Here's why you should use "LIQUISPRAY"

- Abrasives will not settle
- No fire hazard
- No clogging of idle guns
- All the compound sticks to the wheel
- Leaves work free of dirt and easy to clean prior to plating

Choice of heavy cut, cut and color, or color in either tripoli or stainless steel grades

We invite your inquiry specifying your particular requirements. Samples available.

GEORGE A. STUTZ MFG. CO.

1643 CARROLL AVENUE, CHICAGO 12, ILL.

"Complete metal finishing equipment and supplies"

Equipment and Supplies

strips, cotton batten, grinding wheel sludge, and other waste containing diamond dust. This material is then shipped to the Astra Corporation where the waste is processed and 60 to 95 per cent of the diamond dust is reclaimed.

The dust is graded in micron sizes to the customer's specification, analyzed with a spectrograph, and tagged with a certified inspection slip. Then the dust is packed ten carats per ampoule and shipped back to the customer. For further details, use Reader Service Card.

E—1021. Barrel Loader—Newest accessory developed for the recently introduced Gill-Singleton plating barrel is a handy, semiautomatic loading shute and cylinder support stand now offered by the G. S. Equipment Company, Cleveland, Ohio.

Primarily designed for Gill-Singleton barrels, it is manufactured in various sizes to fit all makes of cylinders and superstructures.

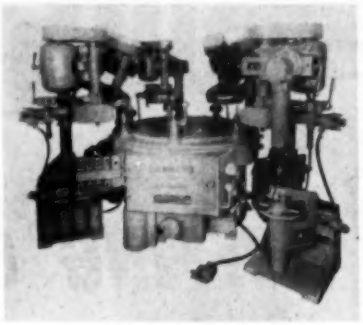
Simplicity of operation, versatility, and rugged all-welded construction are featured at moderate cost. The receiving end of the shute is flush with floor level for easier loading of materials to be cleaned or plated.

It operates with any type of hoist and is quickly attached to the hook at waist height without stooping. It tilts automatically as it lifts, discharging a full load into the cylinder in one operation. For additional information, use Reader Service Card.

E—1022. Rust Remover—Rustgon is a completely new, nonacid rust-removing material that simultaneously strips paint, rust, and primer from ferrous metal surfaces. Developed by Turco Products, Inc., Los Angeles, the liquid alkaline material requires only two simple steps—a dip and a pressure rinse.

The Rustgon method of rust, paint, and red-oxide primer removal eliminates, it is claimed, the need for elaborate multitank installations. Parts to be derusted and stripped of paint and primer are merely immersed into the Rustgon hot tank, withdrawn, and then rinsed with air and water or with steam. For an illustrated brochure, use Reader Service Card.

E—1023. Polishing and Buffing Machine.—A recent new development by Hammond Machinery Builders, Inc., Kalamazoo, Mich., covers a larger rotary automatic indexing polishing and buffing machine. Known as the model K-62-7, it will accommodate up to six head and stand units. The indexing turret is 62 inches outside diameter and 42 inches high from floor to top of spindles. The machine operates on a constant high-speed index movement of one second and has an adjustable dwell period. The table is locked in each indexed position by a



tapered lock bolt that engages the table. The lock bolt is pulled from the table prior to indexing by a cam on the Geneva lever shaft. Table work spindles are driven by a $\frac{3}{4}$ hp motor and a variable speed of 15 to 45 rpm or 50 to 150 rpm and operates entirely independent of the indexing operation of the machine. The table is equipped with seven-work spindles, six of which support and rotate the work at the wheel station and the other is at the operator's station in front of the ma-

AVOID COSTLY REJECTS DUE TO UNACCEPTABLE COATING THICKNESS!

For quality control and acceptance tests, measure thickness of coatings on metals the easy, accurate, non-destructive way, with the . . .

AMINCO BRENNER **MAGNE-GAGE**

Widely used by industry and government for accurately measuring the thickness of:

1. Non-magnetic coatings (metallic or non-metallic) on magnetic base metals.
2. Nickel coatings on magnetic or non-magnetic base metals.
3. Composite copper-nickel coatings on magnetic base metals.

Measures coatings on plane, convex or concave surfaces. Gives speedy and accurate results. Easy to use by non-technical personnel.

Coating on cylindrical object being measured with the Magne-Gage.

Avoids expensive rejections due to coatings that may be too thin, or non-uniform. Eliminates the expense involved in replating or discarding specimens spoiled by destructive tests . . . every piece tested is unharmed and ready for use or shipment. Saves materials wasted by coatings thicker than necessary. Its use leads to the discovery of faults that may exist in plating methods or equipment.

Write for Bulletin 2150-Y

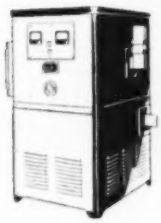
AMINCO Laboratory Instruments

AMERICAN INSTRUMENT COMPANY, INC.

Silver Spring, Maryland • In Metropolitan Washington, D. C.

AMPERES BY THE MILLIONS

Udylite pioneered the first standardized rectifier for the plating industry in 1940. To date 26,000,000 amperes have been sold and installed.

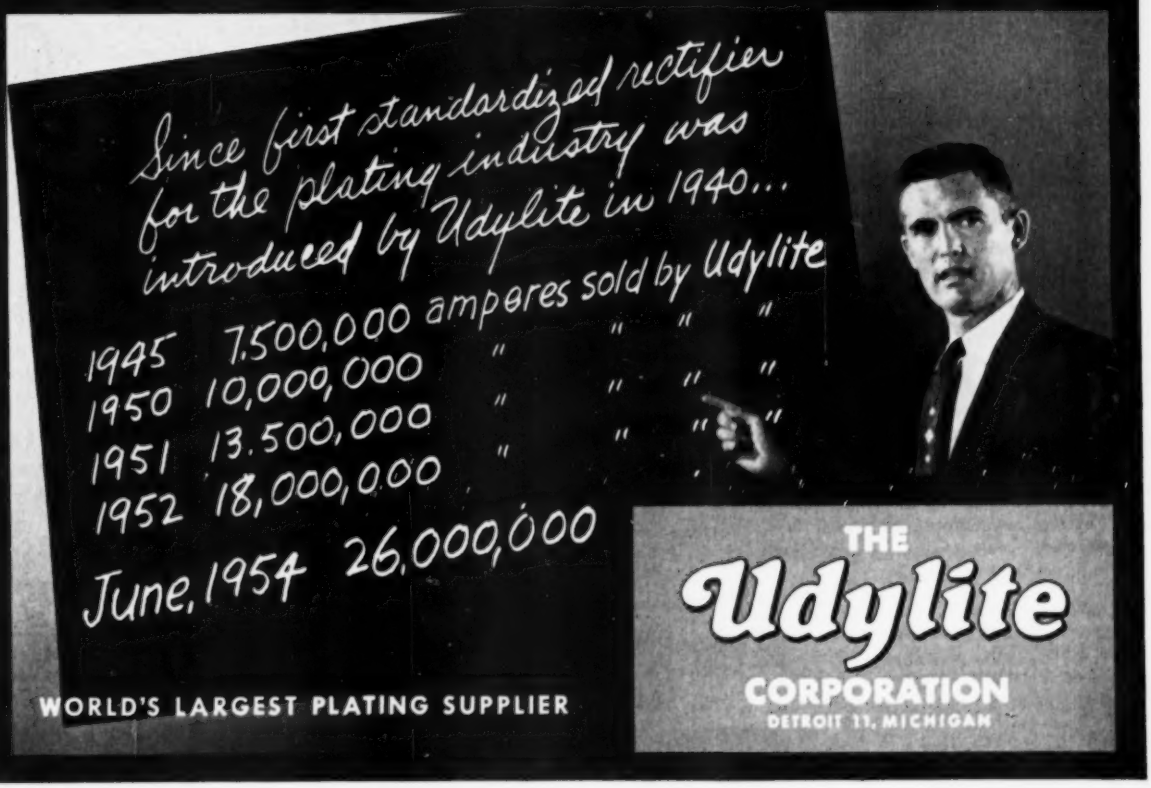


Yes, it's know-how that counts. Back fourteen years ago when Udylite brought out the first magnesium-copper-sulphide rectifier the capacity was 1500 amperes, 6 volts. Many of these rectifiers are still in operation today. But great progress has been made in the application of electrical power to plating operations since 1940. Through research Udylite electrical engineers have developed and improved selenium rectifiers.

Udylite's complete line of first quality selenium rectifiers range from the bench-type furnishing 25 amperes to big banks of rectifiers with output up to 100,000 amperes. But building a good rectifier is only part of the job. The *application* is equally important. That's why Udylite "know-how" helps you. When you buy Udylite rectifiers you can be sure that the application is right, and your power is used efficiently.

Thousands of plating customers have learned the importance of Udylite application "know-how". That's why our rectifier sales increase each year. Yes, that's why we have sold 26,000,000 amperes of rectifiers since 1940.

If you need rectifiers for electro-plating, electro-cleaning, electro-polishing, anodizing or hard coat process call your Udylite representative or write direct to . . . The Udylite Corporation, Detroit 11, Mich.


Since first standardized rectifier for the plating industry was introduced by Udylite in 1940...
1945 7,500,000 amperes sold by Udylite
1950 10,000,000 " " " "
1951 13,500,000 " " " "
1952 18,000,000 " " " "
June, 1954 26,000,000
WORLD'S LARGEST PLATING SUPPLIER
THE
Udylite
CORPORATION
DETROIT 11, MICHIGAN

Equipment and Supplies

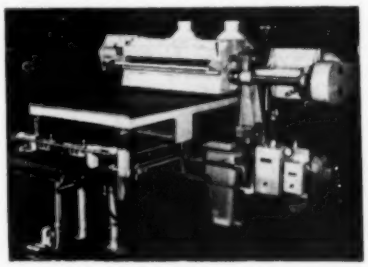
chine for loading and unloading. To assist the operator, the spindle at the operator's station does not revolve, but is stopped and held by a spring tensioned brake. This brake also serves to start rotation of the spindle as it is indexed into the moving table chain, thereby reducing wear to a minimum. The machine, complete with six head and stand units weighs approximately 11,500 pounds. For additional information, use Reader Service Card.

E—1027. Portable Plating Barrel—A plating barrel weighing 27 pounds designed for small quantities and fabricated in acrylic is announced by Starline Products, Los Angeles.

Inside dimensions are 6 x 12 inches with $^{3}/_{32}$ inch perforations. Gears and sides are $^{5}/_{8}$ inch thick and withstand 180° F. All metal parts exposed to plating solution are made of Monel. For more information use Reader Service Card.

E—1028. Surface Finishing Machine—A new heavy-duty surface finishing machine with a vacuum chuck for processing items of nonmagnetic materials has been developed by Clair Manufacturing Co., Inc.

A modification of an earlier machine, the Clair Model 203-C was designed to provide greater capacity in the surface finishing of automobile trim and name plates for refrigerators, stoves, and other appliances. It is recommended for processing items made of brass, copper, silver, plastic, aluminum, wood, and other nonmagnetic materials.



Completely new electrical control circuits offer a wide choice of either automatic or semiautomatic cyclic actuations. Side oscillation mechanism is located at mid-table rather than at the front and extreme ends as on other machines in the 203 series.

The added capacity comes from the larger vacuum table, a 10 x 48 inches unit as compared to 36 x 38 inches on the earlier model. Design of the vacuum chuck is such that even small items can be held and surface finished without interference with coverage over the entire surface.

For additional details, use Reader Service Card.

E—1029. New Impregnated Buffs—An improved metal-finishing buffing wheel is announced by Hanson-Van Winkle-Munning Company, Matawan, N. J. The new buff cuts faster than former company models and wears 30 per cent longer, the company claims.

Tested during regular production runs, the new buff practically eliminates break-in time. At one installation, for example, it was found that no rejects were turned out by the new buff after five minutes breaking-in, where conventional buffs frequently took a half-hour to break in.

Called a Binderized Ruff-L-Buff, the new buff is impregnated with the same organic material that is used as a binder in buffing compounds. The cloth in H-VW-M's standard line of Ruff-L-Buffs is not impregnated, and the two lines differ only in this respect.

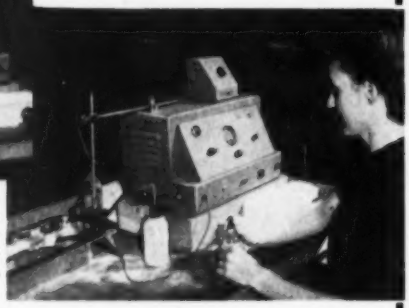
Forming a natural bond between buff and cutting compound, the impregnated binder permits thread ends to retain the compound more easily, more quickly, and in larger quantity. The more compound carried, the less frequently are additional applications required and the faster the cut under all conditions.

Grease-like in nature, the binder also tends to make the buff softer and more flexible during operation. Laboratory tests conducted by H-VW-M show that constant flexing damages the cloth of conventional buffs in an area beginning 1 inch from the periphery, and the cloth becomes progressively weaker as the buff

KING-SEELEY CORPORATION, ANN ARBOR, MICHIGAN

solves thickness testing problem
WITH
KOCOUR ELECTRONIC THICKNESS TESTER

BELOW: To conform to specifications, operator can check work quickly, as it progresses. This is a regular production control operation at King-Seeley Corp.



ABOVE: King-Seeley Corp., manufacturer of automotive gauges, governors, interval timers and electrical appliances, conveniently ocated the Electronic Thickness Tester in production department.

About 2 years ago the King-Seeley Corp. purchased the Kocour Electronic Thickness Tester . . . evaluated the instrument and have been using it since with confidence and satisfaction. Mr. C. F. Waite of that company wrote a paper, "Thickness of Electrodeposited Coatings by the Anodic Solution Method" concerning their problems and how they were solved.

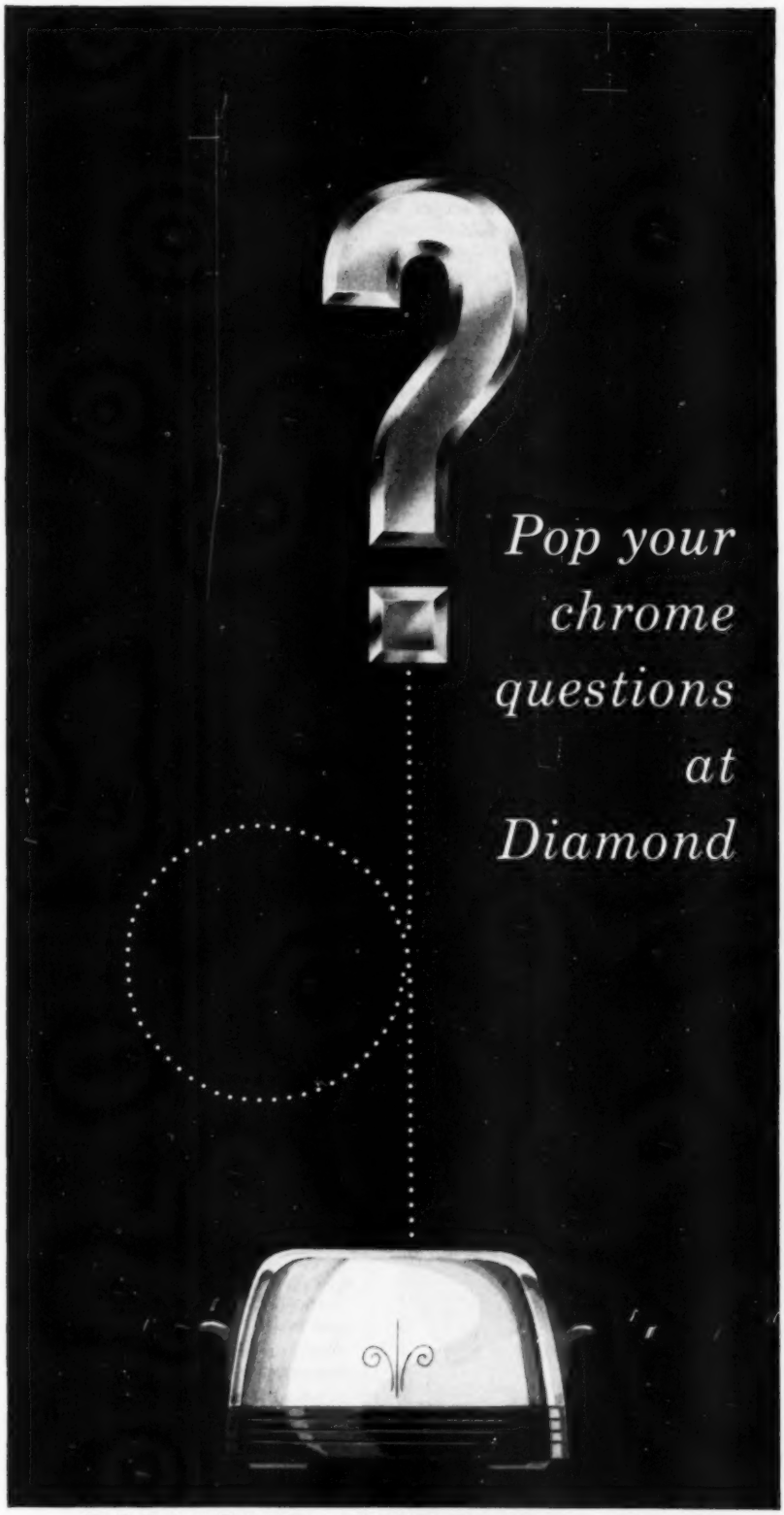
King-Seeley Corp. is one of the many companies which are now saving hours of control and production time with the Electronic Thickness Tester. In addition, more efficient operation and higher standards of quality can be maintained confidently.

Why not investigate the possibilities today. See how the Kocour Electronic Thickness Tester can solve your problems.

Write for literature and get your copy of "Thickness of Electrodeposited Coatings by the Anodic Solution Method."

KOCOUR CO.
4801 S. St. Louis Ave.
Chicago 32, Illinois

Always specify KOCOUR TEST SETS from your supplier!



DIAMOND CHROMIC ACID

Here at DIAMOND we are all set to pop up with answers to almost any question about chrome plating that comes along. Our Chromium Chemicals Division has experts that do nothing else. And they do it without charge.

Our technical background comes from broad experience. We are in the chrome business up to our ears. For instance, we import the ore, make the soda ash and from there on, control every process in the making of DIAMOND chromic acid . . . extra assurance of uniform quality that helps you to get more uniform, more profitable results.

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wears down. Tests also show that the softer impregnated buffs wear as well on the last inch as the first.

Binderized Ruff-L-Buffs are available in a wide variety of plys and weights with outside diameters of 12, 14, 16, and 18 inches. Nonstandard sizes may be had on request. For further information, use Reader Service Card.

E—1030. New Electronic pH Controller—A new electronic indicating *p*H controller available with a variety of electric control actions has been announced by the Bristol Company of Waterbury, Connecticut. Featuring a newly developed high-torque, jeweled, millivoltmeter-type movement, the instrument has an easy to read 7-inch mirror scale and a dustproof and vaporproof case.

The new controller is available in the following electric control actions: two-position, two-position with normal zone, two-position with proportional-input, and three-position control. It will actuate a wide variety of final control devices, permitting *p*H control with any type of reagent, whether liquid, gaseous, or solid.

Complete specifications and illustrations may be obtained by using Reader Service Card.

E—1031. Automatic Plating Machine—Frederic B. Stevens, Inc., have announced the development of a new full automatic side arm type machine for electroplating and allied processing finishes. The new machine supplements the existing Stevens line of automatic rack and barrel type plating and processing equipment.

The new automatic plating machine was christened the "Stevadoer" by James Barton, Stevens chief engineer, who designed the unit.

The Stevadoer incorporates modern design features that will meet today's requirements of low head room and high lift. It also offers Stevens delayed set down methods and the new projected safety requirements. The transfer method is entirely revolutionary and provides for automatic load and unload.

For further information, use Reader Service Card.

E—1032. Backstand Idler Offers Easy Remote Control For Belt Tracking and Take-Up Tension—A new heavy-duty backstand idler with a 6-inch wide plastic wheel has been developed by Fenlind Engineering Co., Rockford, Ill., for use with belt grinding machines. Its width affords outstanding flexibility in grinding belt selection. Two remote control arms offer more accurate tracking and tensioning than most other idler designs.

Width of the idler wheel permits a belt width range of ¼ to 6 inches. Use of plastic in the wheel prevents marring of the surface by abrasive particles. This marring does occur with conventional metal pulleys and not only interferes with proper tracking but also shortens wheel life.

Called the Fenlind L-29 Backstand Idler, the unit has two control arms which extend from the idler to within easy reach of the operator at the grinding lathe. A range of contact wheels from 3 to 16 inches in diameter may be accommodated by this traversing mechanism. For more information, use Reader Service Card.

E—1033. New Acid and Plating Hose Announced—Carl Buck and Associates, Essex Fells, N. J., announced a new line of hose designed to handle hot acids and all plating solutions that is now available for shipment out of stock in sizes of 1, 1½, 2, and 2½ inches. Larger sizes can be provided if needed on reasonable delivery schedules.

This hose is designated as Camac Acid and Plating Hose and is constructed of Butyl rubber with four-ply reinforcing. Tests have proven the ability of this hose to stand up under all hot acids except nitric or chromic. Further tests show that the hose does not contaminate plating solutions. Descriptive data sheets and prices are available by using Reader Service Card.

E—1034. New Technique for Finishing Plastic Automobile Bodies—A new and economical method for surface preparation of glass fiber reinforced plastic

GRIND
POLISH
BUFF
DEBURR
with a Hammond ROTARY AUTOMATIC

Model "K" Hammond Automatic Finishing Machines are made in 34", 46" and 62" table sizes. These models are either continuous or for indexing at 150 to 1700 indexes per hour. Head styles include floating, non-floating with 5 H.P. to 20 H.P. range. Also available are attachments for converting heads from buffing to abrasive belt polishing. The Hammond Model "K" will speed up your grinding, polishing, buffing, brushing and de-burring operations. Send us samples and learn how much you can speed them up.

SEND SAMPLES and we'll show you how much you can speed production and cut costs.

Hammond Machinery Builders INC
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automobile bodies has been developed by DeVilbiss Company technicians. The new method, which substantially reduces surface preparation time, opens the way to painting the bodies in the conventional manner, using dark, medium, or light colors.

DeVilbiss, long a leader in the development and manufacture of spray painting equipment, worked out the new technique, using a Kaiser Darrin, manufactured by a Toledo neighbor, Willys Motors, Inc.

In addition to development of an economical method for surface preparation, DeVilbiss technicians were interested in obtaining a smooth surface on the body so dark colors, previously not used, could be applied.

In working on the body, DeVilbiss technicians used new materials and newly developed spray equipment which consisted principally of a special spray gun equipped with a two-stage external mix cap. The gun is equipped with high-fidelity controls to govern a complete and thorough mixture of catalyst and resins. For more information, use Reader Service Card.

E—1035. Vacuum Coater Features Built-in Photometer—A built-in optical photometer is used to measure coating thickness in a new vacuum coater made by American Instrument Company, Inc. The photometer consists of a collimated light source and a sensitive photomultiplier detector. The detector can be placed to receive light reflected from the work or transmitted through the work.

Thicknesses are measured by recording a change in reflected or transmitted light while the coating is being applied. Space is provided for placing any type of filter in the optical path, and the detector is sensitive enough to record full-scale light reflected from plain, uncoated glass.

Complete details are given in Bulletin 2252, obtainable by using Reader Service Card.

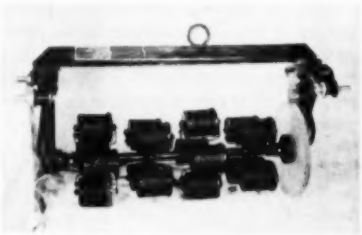
E—1036. Automatic Degreaser Has Powerful Turbulent Action—A new, automatic cold washing degreaser, designated as the Super Cleanmaster Model 50, is announced by the Kleer-Flo Company, New York. The machine employs a powerful turbulent action created by compressed air which combines with the penetrating chemical properties of the cleaning compound, enabling it to remove heavy deposits of oil, dirt, grease, and chips from all types of metal parts.

A patented electric pump prolongs the life of the cleaning compound by continuously filtering out dirt, chips, and abrasives. The machine is equipped with a full-length air agitated soaking tank, hinged work shelves, parts basket, drying shelf, and a compressed air gun for faster parts drying. Mounted on casters, the Super Cleanmaster can be moved easily to any part of the shop for "on the spot" production or maintenance cleaning operations. For additional information, use Reader Service Card.

E—1037. The Udylite Cluster Barrel. One of the largest manufacturers of computing machines asked the Udylite Corporation for advice and assistance in solving a plating problem inherent to the office machinery business.

These manufacturers plate millions of small parts and types which cannot be mixed. This means plating always in small well separated batches yet on a large production scale.

The problem was solved by Udylite barrel plater engineers. The Udylite Cluster Barrel provides a rotary rack to hold small containers with the proper constant current conducted to each container. The mechanism consists of a shaft rotated by means of a large ring gear. On the shaft are mounted, at intervals of about eight inches, four spoke arrangements. Each spoke carries a perforated steel plastisol covered container held in place



by "C" shaped spring clips which also serve to hold the removable lid in place. For loading and unloading, the small containers are easily snapped out of the clips and the lids are simply lifted off the containers. Each container has a built-in

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ZIPPO CLOTH BUFFS

These famous long-wearing buffs run cool under all buffing conditions. High count bias-cut cloth is assembled on ventilated steel centers. Each section is perfectly balanced and faced—requires no raking.

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Our extensive manufacturing, laboratory and testing facilities are at your disposal.

ZIPPO SISAL BUFFS

You have a pleasant surprise coming if you haven't tried the new Zippo bias-type sisal buff. It was specifically developed for steel buffing—to blend polishing grit lines—to cut down stainless steel—and bring up a bright lustre.

Other Formax products include the well-known C-20 Flexible Contact Wheels and F-26 Abrasive Belt Grease Stick.

Descriptive Catalogs Sent on Request

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"THE FOUR McALEERS"

disc type cathode contact making it a complete unit in itself.

The Udylite Cluster Barrel with its bail type superstructure can be used in the standard plating barrel.

It is particularly well adapted to the plating of business machine, radio, radar parts, or any such products where plating is required and the parts must be kept separate. It is also of good use to anyone plating small delicate parts which cannot stand the tumbling action of standard bulk plating equipment. For more information on this equipment, use Reader Service Card.

E—1038. Mechanical Booster Vacuum Pump—The Kinney Manufacturing Division of the New York Air Brake Company at Boston has introduced a new mechanical booster vacuum pump for use as a high vacuum stage in the low pressure range where single stage vacuum pumps have poor volumetric efficiency. Designated as model MB, it is a rotary positive displacement pump equipped with mechanical shaft seals.

As a vacuum booster pump, it is specially designed to exhaust into the inlet of a Kinney single stage pump acting as a second stage or backing pump.

The combined unit has a far wider high vacuum range with lower power consumption than has been realized up to now by commonly employed mechanical pumping principles. For more information on this unit, use Reader Service Card.

E—1039. All-Purpose Placo Filter Unit Introduced—After several years of successful testing in the field, the new Placo self-priming and self-relieving filter unit is now ready for national distribution, it was announced recently by Metal Finishing Manufacturing Corporation of Brooklyn, N. Y.

Constructed of type 316 stainless steel, these units are ideal for filtering all acid and alkaline solutions. Long-life neoprene impeller, large graphite bearings, and ball bearing ring enclosed motors assure convenient, trouble-free operation under any conditions. The Placo filters in depth, through cartridges of cotton, dynel, and carbon, making possible microscopic clarification, including removal of colloidal solids.

No priming is necessary to operate the Placo filter; a flick of the switch starts crystal-clear filtration at full pressure. When the filter is loaded with impurities, the flow rate is automatically reduced to a trickle to warn that the cartridge needs cleaning or replacement. Placo filter units are available with capacities from 60 to 1600 gallons per minute.

Additional information can be obtained by using Reader Service Card.

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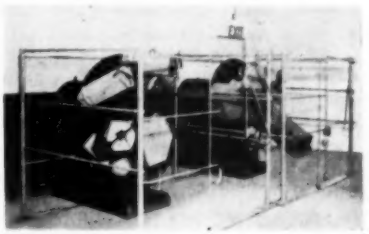
E—1040. New Concept in Precision Tumbling—A new approach to tumble finishing called "Slidehoning" has been announced by the BMT Manufacturing Corporation, Elmira Heights, N. Y.



The BMT Slidehoning equipment is a multibarrel unit with a 48-inch revolving disc on which can be mounted as many as 25 barrels with a variable rotating speed from 11 to 28 rpm and with different sizes and shapes of barrels available, plus a range of mountings. The BMT Slidehoning equipment makes possible a combination of rotary, centrifugal, and slide tumbling actions all at one time—not just the conventional mass-weight tumbling.

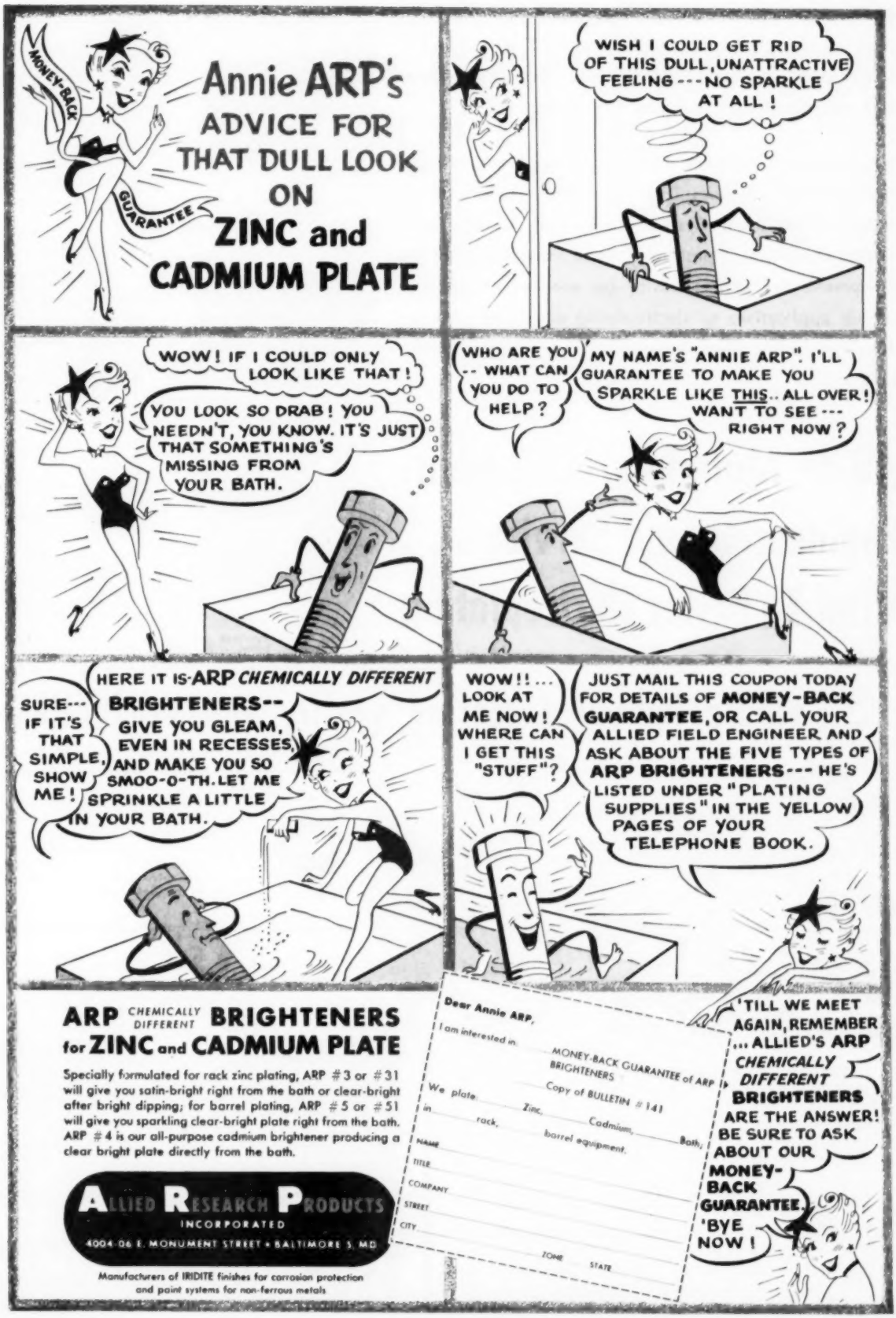
The controlled-motion honing possible with the BMT multibarrel unit removes burrs, flash, tool marks, rust, paint, plating, and heat treating scale and does not effect the dimensional tolerances of the work piece. Such operations as rounding corners, forming fillets, and blending chamfers can all be successfully done, according to Donald Mosher, president of the corporation, with the finished surface and the appearance of the part materially improved. The BMT equipment permits one operator to do effective finishing on a variety of work pieces; both wet and dry tumbling can be done at the same time. Mosher emphasized that one BMT unit with eleven barrels is equivalent to eleven conventional tumbling machines.

For further information, use Reader Service Card.

E—1041. New Polishing and Buffing Head—Another new machine has been added to the line of finishing equipment of Hammond Machinery Builders, Inc., Kalamazoo, Michigan.

A new polishing and buffing head, Model 52-100, will accommodate either a 10 or 15 hp, 1750 rpm or a 20 hp, 3500 rpm motor. Net weight of 2500 lb indicates the rugged construction necessary for heavy buffing jobs and to insure vibrationless operation. It has a maximum float of 6 inches and can be furnished with power feed for vertical lift or horizontal traverse.

This head unit, which can be assembled for either right or left-hand operation, was designed especially for use with Strait-Line automatic buffing machines. It can be used also with rotary automatics or as individual polishing and buffing stands similar to polishing and buffing lathes. For additional information, use Reader Service Card.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Annie ARP's
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ON
ZINC and
CADMIUM PLATE
WISH I COULD GET RID OF THIS DULL, UNATTRACTIVE FEELING --- NO SPARKLE AT ALL !
WOW ! IF I COULD ONLY LOOK LIKE THAT !
YOU LOOK SO DRAB ! YOU NEEDN'T, YOU KNOW. IT'S JUST THAT SOMETHING'S MISSING FROM YOUR BATH.
WHO ARE YOU -- WHAT CAN YOU DO TO HELP ?
MY NAME'S "ANNIE ARP". I'LL GUARANTEE TO MAKE YOU SPARKLE LIKE THIS.. ALL OVER ! WANT TO SEE --- RIGHT NOW ?
SURE--- IF IT'S THAT SIMPLE, SHOW ME !
HERE IT IS-ARP CHEMICALLY DIFFERENT BRIGHTENERS-- GIVE YOU GLEAM, EVEN IN RECESSES, AND MAKE YOU SO SMOO-O-TH. LET ME SPRINKLE A LITTLE IN YOUR BATH.
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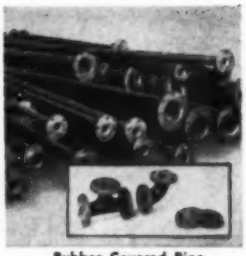

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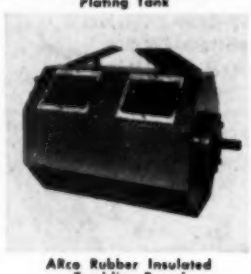

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THE AMERICAN ELECTROPLATERS' SOCIETY RESEARCH PROGRAM*

DR. EARL J. SERFASS†

It has become traditional, or almost traditional, to devote one educational session of the Annual Convention to reports of the various research projects that have been active during the previous year.

This year we have, however, defied tradition and have interspersed in the various educational sessions the final reports of several of the projects that are active. We have not included partially completed work or tentative reports this year.

The summary of the activities of the Research Committee appears in detail in the June issue of PLATING, in the annual report submitted to this Society, so that this will be a brief review of the several active and inactive projects and the results of these activities.

Table I shows that there have been active, as far as experimental work is concerned, ten projects during the past year. These projects have been carried out at six different institutions. As a result, we have produced nineteen scientific publications, which have appeared in PLATING as final reports.

We have in committee at present a number of papers resulting from this work. These papers will appear in PLATING within the next few months. The projects are sufficiently active to assure a continuing flow of research results to the Society.

Table II shows the projects that are now active or recently have been inactivated and the titles of these particular projects.

TABLE I. REPORTS PUBLISHED 1953–1954

Project	Papers	Project	Papers
2	4	11	1
4	1	12	4
5	1	13	2
6	3	14	1
10	1	15	1
Total		19 Papers; 10 Projects	

TABLE II. RESEARCH PROJECTS

Project	Location	Project Director	Subject	Remarks
2	Lehigh	E. Serfass	Plating Process Control Handbook	Active
4	.....	.....	Surface Finishing of Nonferrous Base Metals on the Protective Value of Plated Coatings	Being Concluded
5	Michigan	D. Ewing	Effect and Removal of Impurities	Active
6	.....	.....	Porosity of Electrodeposited Metals	Last Report Submitted
10	Yale	B. Dodge	Disposal of Plating Room Wastes	Inactive

*Presented at the Forty-First Annual Convention of the American Electroplaters' Society, 13 July 1954.

†Head, Department of Chemistry, Lehigh University, Bethlehem, Pa., and Chairman of the AES Research Committee.

TABLE III. RESEARCH PROJECTS

Project	Location	Project Director	Subject	Remarks
12	Columbia	H. Linford	Cleaning	Active
13	Bureau of Standards	F. Ogburn	The Nature, Cause, and Effect of Porosity in Electrodeposits	Active
14	Ontario Research Foundation	A. E. R. Westman	Effect of Basis Metal Condition on Plating	Active
15	Detroit Area	None	Accelerated Corrosion Tests	Active

Project No. 2, under my direction at Lehigh University, deals with a plating process control handbook. We hope this handbook will be in the publisher's hands within the next six to eight months.

Project No. 4 is inactive; the last paper is now in the hands of the committee, and the test results of the plating and corrosion studies will be presented.

Project No. 5 is active. A paper will be presented at this meeting dealing with the effect and removal of certain impurities from nickel plating baths.

Project No. 6, because of the death of Professor Thon at Princeton, is now inactive, but Dr. Weisberg succeeded in writing up the last of the data and has presented the paper for publication.

Project No. 10 is inactive at the moment due to the lack of a fellow, but Professor Dodge is still active in the field of waste disposal and will discuss at this Convention certain aspects of waste control.

Table III shows four projects which are at present active—Project No. 12 at Columbia, Project No. 13 at the Bureau of Standards, Project No. 14 at the Ontario Research Foundation, and Project No. 15 in the Detroit area.

Project No. 12—on cleaning—is quite active, and Professor Linford will present here a paper dealing with the preparation of the equipment for studying the cleaning of metals insofar as oxide films are concerned.

The nature, cause, and effect of porosity—Project No. 13—is being actively studied at the Bureau of Standards, using tracer techniques.

The Ontario Research Foundation paper—Project No. 14—will be presented here.

Project No. 15, one of our most active, is active in the Detroit area developing, we hope, a new accelerated corrosion test and possibly several such comparative tests.

Table IV shows the cost of operating this rather active Research Program. The expenses, as shown for this past year, are: transferred to Canadian Fund, $5,231; payment to institutions, $4,384; project directors and associates, $5,075; and miscellaneous operating expenses, $1,914; or a total of $16,604 spent from the Research Fund this year. This is a little less than the expenditure for the year 1953, although we do have a rather active group from the standpoint of turnout of work.

TABLE IV. RESEARCH FUND

Expenses:	1954	1953
Transfer to Canadian Fund	$ 5,231	$ 3,000
Payment to institutions	4,384	3,300
Project directors and associates	5,075	7,608
Miscellaneous operating expenses	1,914	4,887
Total	$16,604	$18,795

Table V shows the income of the Research Fund for the fiscal year 1953–1954. There has been an increase in income due to the per capita tax, so that total income was $42,345 this past year. We have spent considerably less than the $42,345 for several reasons, as you will see in a moment. The final balance sheet, as of April, 1954 (Table VI), shows that we have in the Research Fund a comfortable margin of $75,009 for carrying on research in the next few years. Part of the reason for a backlog of funds is that many of the projects have been operating at considerably less than the cost we had anticipated.

Project No. 15 used no Society funds; neither did Project No. 2. Furthermore, we have had considerable difficulty getting new projects started at institutions because (1) graduate students are difficult to obtain at the present time and (2) only certain institutions will accept projects of the type that the AES is willing to sponsor.

Within the next year or two, it may be necessary for us to examine the possibility of placing projects at research foundations other than universities.

We have started no new projects this year, although we have set up a series of task committees to investigate the possibility of starting new projects. These include task committees on micro throwing power, the role of anion in plating, and quantitative measuring instruments for plating.

Another task committee that has aroused some interest is the one studying the possibility of starting or reactivating a project on current and metal distribution in plating.

This is a brief outline of the Research Committee finances, as well as of the projects that are active or that may be started this coming year.

I would like to thank all of those members of the various committees who assisted me during the past year in carrying out the activities of the Research Committee. Many of you realize that approximately 80 members of the various subcommittees of the Research Committee are active in traveling and in organizing, as well as in directing these various research programs. All of these members of the subcommittees offer their services free to the Society. As a consequence, we obtained a considerable amount of high-quality research for a rather low expenditure of Society funds.

TABLE V. RESEARCH FUND

Income:	1954	1953
Dues and sustaining members	$34,050	$31,231
Per capita tax	5,988	.....
Miscellaneous income	2,307	5,006
Total	$42,345	$36,237

TABLE VI. RESEARCH FUND

	1954	1953
Excess of income	$25,731	$17,441
Balance (April 1, 1954)	49,278	31,836
Total (April 1, 1954)	$75,009	$49,278

I would also like to thank you for permitting me to act as your Chairman this year. I hope always to be available to assist in carrying out the Research Program in some way or other.

* * *

In a paper presented at the Fourth International Conference on Electrodeposition and Metal Finishing in London, Dr. Frederick A. Lowenheim of Metal and Thermit Corporation, Rahway, N. J., said:

"The use of tin-zinc alloy plating has continued to expand at an accelerated rate, to the extent that this process now appears firmly established, with every expectation of further growth. This has come about in spite of the ready availability of cadmium, as a substitute for which tin-zinc was at first promoted.

"It is not, however, as a cadmium substitute that tin-zinc has made its principal impression but as a finish having notable properties not entirely shared by any other deposit. It would, in fact, be fair to say that in respect to the principal application for which tin-zinc alloy plating has so far found favor, cadmium would be the substitute. In the electronic and electrical fields, a combination of properties is required—easy solderability, retention of this solderability on aging, and reasonable resistance to corrosion—and it is in this combination that tin-zinc has been found to excel.

"Solderability is an elusive term. There is in the United States no generally accepted test by which it can be measured and expressed in quantitative terms. The usual criterion of solderability is the purely practical if subjective one of satisfactory performance on the assembly line. The trend toward miniaturization in electronic assemblies is one of the factors that have emphasized the desirability of a coating that can be easily wet by standard solders; in most such assemblies only the mildest and least corrosive fluxes can be tolerated.

"The demand for a coating that will retain its solderability over long periods of storage has arisen partly as the result of the need for maintaining inventories of many different types of components and partly through increased emphasis on the importance of easy servicing in the field, which may be very distant both in time and place from the point of manufacture.

"The coatings conventionally regarded as meeting standard solderability requirements have been cadmium, tin, tin-lead alloy, and silver; to this list tin-zinc alloy must now be added—and according to many observers it belongs at the top of the list, particularly in regard to shelf-life."

A NEW INSTRUMENT FOR MEASURING STRESS IN ELECTRODEPOSITS*

JOSEPH B. KUSHNER†

Introduction

The subject of stress in electrodeposits is one that has troubled, exasperated, and mystified the plating industry for nearly one hundred years. Probably the earliest recorded observation of this peculiar phenomenon was that of the English chemist Gore. In his book "The Art of Electrometallurgy," published in 1858, he writes: "In electrodeposits, generally the inner and outer surfaces are in unequal states of cohesive tension, frequently in so great a degree as to rend the deposit extensively and raise it from the cathode in the form of a curved sheet with its concave side to the anode."

This rhetorical way of saying that stress causes the plate to crack, peel, and distort is the clue to the source of trouble and exasperation, but the mystery is that from Gore's day to this no one yet has correctly explained what really causes stress. Hidden in the atomic lattice is the secret of the enormously powerful forces that plague the plater under the name of stress.

In order to fathom the atomic depths for the cause of stress, we need a yardstick that will accurately measure these forces. With such a yardstick, if it is precise enough, it may be possible to correlate stress with such factors as current density, polarization, temperature, *p*H, atomic structure, concentration, viscosity, surface tension, and time. From these correlations, if they exist, we can learn much of immediate practical value to the plater.

For example, Almen[1] has shown that the fatigue strength of steel is considerably diminished when it is coated with a metal in a state of tensile (contractile) stress. On the other hand, he has also demonstrated that the fatigue strength of steel is considerably increased when it is coated with a metal in compressive (expansive) stress. This is just one of the many wide avenues open to the practical explorer of stress phenomena that can lead to direct bread-and-butter results.

More important than the immediate useful knowledge that is gained from such explorations is the fact that we may be able to piece together the bits of information gathered on the way, just as we put together a jigsaw puzzle, to obtain a clear picture of the true cause of stress. With such a picture we will have a better insight into the nature of an electrodeposit.

Many attempts have been made at fashioning a yardstick for measuring stress. Mills[2] in 1877 silvered the glass bulb of a mercury thermometer, then plated it with nickel, and noted what he called an "electrostrictive" effect that caused the mercury to rise in the stem of the thermometer above and beyond the point in equilibrium with the temperature of the surroundings. This was, however, a rather poor yardstick because of the difficulty of preparing it for the measurement, the difficulty of translating the measurement into known force units, and the fact that the small radius of curvature of the glass bulb induced premature cracking of the deposits, thus making the measurements worthless beyond the cracking point. Accordingly, this approach was discarded, and a renewed search was made for a stress measuring instrument.

In 1909 Stoney,[3] the scientist who gave us the word "electron," designed a stress measuring device based on the flexure of a thin metal strip. This principle has been the basis of every stress measuring instrument since, including the recent ingenious spiral contractometer invented by Brenner.[4] Since Stoney's method is so fundamental, it is of interest to examine it in some detail.

Stoney's Stress Measuring Method

Stoney's apparatus consisted of an ordinary steel rule, stopped off on one side with insulating varnish. He plated the rule in a nickel bath and observed that the rule was then bowed inward on the side holding the nickel deposit, as illustrated in Fig. 1. The apparent overall shrinkage of the deposit had exerted a force that caused the rule to bend in such a way as to permit the nickel layer to occupy less space.

While there are some complex aspects to the mathematical treatment of this system, which have been discussed by later authors,[5,6,7] Stoney, by treating the rule as a simply supported beam under uniform loading, obtained a formula that gave the stress in the

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*Presented at the Forty-First Annual Convention of the American Electroplaters' Society, 13 July 1954.

†Director, Joseph B. Kushner Electroplating School, Stroudsburg, Pennsylvania.

deposit in terms of the deflection at the center of the strip from its normal unflexed position. This formula is:

$$S = \frac{4\,E\,h^2\,Y}{3\,t\,L^2} \qquad (1)$$

where

S is the stress in pounds per square inch; E is the modulus of elasticity (Young's Modulus) of the rule material; h is the thickness of the rule; Y is the deflection; t is the thickness of the deposit; and L is the length of the plated part of the rule.

The drawback to methods based on the deflection of a metal strip is that since the deflection Y is normally quite small, in the order of a few hundredths of an inch or less, it must be determined by an external measuring system that is not part of the instrument itself. Thus, the deflection is generally measured with a traveling microscope or sensitive micrometer. These in turn introduce new possible sources of error and an additional expenditure of time. Where a mechanical magnifying system is made part of the instrument itself in order to get away from this difficulty (such as in the spiral contractometer where the deflection is increased by lengthening the strip in a spiral and further magnified through a gear chain) pivot friction, torsion, and binding can cause serious errors.

While doing some work at Lehigh University[8] in connection with stress, the author found himself dissatisfied with the strip flexure methods of measuring stress and was led to invent the stress measuring instrument described here.* This instrument, which has been named a Stresometer, is based on the symmetrical flexure of a circular plate or disc about its vertical axis when a metallic or nonmetallic deposit is placed on the disc.

Description of the Stresometer

As can be seen from the diagram (Fig. 2), a thin, flat metal disc (a) is clamped in place to form the cover of a shallow chamber (b), filled with a metering fluid (c) such as water. This chamber connects with a vertical precision bore capillary tube (d), partly filled with the metering fluid and open to the air. The disc, which may be made of copper, brass, nickel, or stainless or ordinary steel, is easily removed and mounted by means of the clamping ring (e) and the peripheral bolts (f). A special electrical contact (g) connects the inner face of the disc to a binding post on the stem of the instrument. This is the cathode contact. An insulating gasket (h) prevents any plating solution from mixing with the metering fluid. An

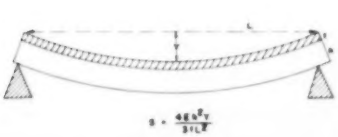

Fig. 1. Diagram of stress measurement by Stoney's method

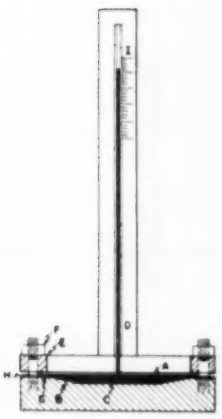

Fig. 2. Diagram of Stresometer

accurately engraved scale (i) measures the rise or fall of the metering fluid in the capillary.

The disc, mounted in the Stresometer, is plated on its outside face in the plating solution under test. A disc type anode and a tube to shield the disc from stray currents are used to insure a uniform electrodeposition of metal on the disc surface. The basic electrical circuit used is shown in Fig. 3.

Assume that the disc is nickel plated. The contractile stress in the nickel plate causes the disc to dish in so that it squeezes some of the metering fluid from the chamber out into the capillary tube. The rise of the liquid in the capillary is then a measure of the stress in the nickel deposit. On the other hand, if the disc is plated with zinc, which shows expansive properties, the disc will bulge out on top, as can be seen in Fig. 4, and the liquid level in the tube will fall. In this fashion the Stresometer measures the stress forces acting on the disc.

Theory of the Stresometer

Any supported disc (provided the disc thickness is small as compared to its diameter) when subjected to a uniform weight distribution or pressure within its elastic range will be symmetrically bent about its vertical axis in such a way that the deflection at the center of the disc is proportional to the uniform force causing the bending. Mathematically stated,

$$Y = \frac{kqA^4}{Eh^3} \qquad (2)$$

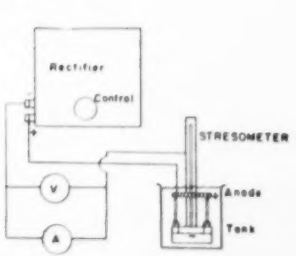

Fig. 3. Diagram of plating circuit for Stresometer

*Protected by U. S. Patent Application 402,466, assigned to the Joseph B. Kushner Electroplating School.

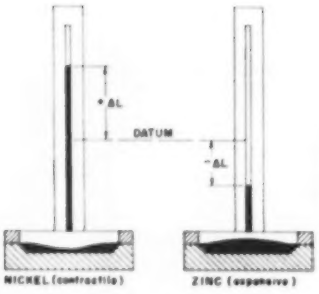

Fig. 4. Diagrammatic description of principle of the Stresometer. Left, nickel exhibiting contractile stress; right, zinc with expansive stress

where Y is the deflection at the center of the disc; k is a constant, the value of which depends essentially on the conditions at the edge of the disc, i.e., whether the edge is built in (clamped) or freely supported; q is the intensity of the loading force in pounds per unit area; A is the radius of the disc; h is its thickness; and E is Young's Modulus for the disc material. This formula, which is readily found in any textbook on the mechanics of materials, is well established and proved in both practice and theory.

Since all the factors on the right side with the exception of q are constant for a given disc, we can write equation 2 as:

(3) $$Y = Kq$$

where K is a lumped constant equal to $\frac{kA^4}{Eh^3}$

In essence this is a statement of a very general law of nature, Hooke's Law: "As the force, so the extension." Put in modern terms, this reads, "Within the elastic range, the ratio of stress to strain is a constant."

It is also shown in advanced texts[9] on the same subject that a clamped disc when subjected to a uniform force over its surface of intensity q acts essentially as though it were subjected to a radial bending moment at its boundary, equal to $qA^2/8$ per unit length, where A is the radius of the disc.

When we plate the disc, we likewise subject the disc to a radial bending moment due to the stress in the plated deposit. At the boundary of the disc, for a unit length along the edge, that moment, M, is equal approximately to $Sth/2$, where S is the stress in the deposit, t is the thickness of the deposit, and h is the thickness of the disc. More accurately, the moment is given by the expression $M = \frac{Sth}{2}(1 + t/2h)$, since the disc is continuously bending until the final increment of deposit is laid down; but since t is much smaller than h as a condition of choice, $t/2h$ can be neglected as compared to unity.

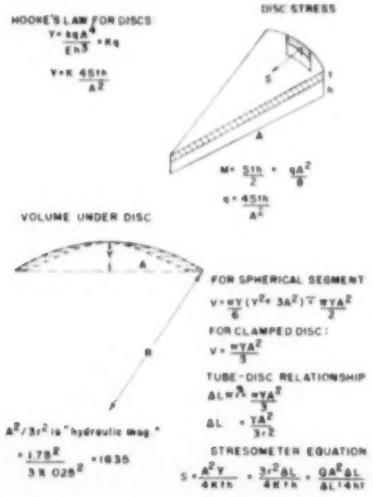

Fig. 5. Theory of Stresometer

The moment, $M = Sth/2$, will obviously cause a flexure of the disc just as though the disc had been subjected to a uniform loading with a force of intensity q, provided that:

(4) $$\frac{Sth}{2} = \frac{qA^2}{8}$$

Thus, the uniform loading force, which will cause an equivalent deflection at the center of the disc, is equal to:

(5) $$q = \frac{4Sth}{A^2}$$

According to equation 3, the deflection at the center of a clamped disc, due to an electrodeposit under stress, will be given by:

(6) $$Y = K\,\frac{4Sth}{A^2}$$

It can be seen from this relationship that the deflection at the center of the disc will vary linearly and directly with the stress in the deposit.

The next point of interest is the relationship between the deflection and the rise or fall of the metering fluid in the capillary tube.

If it is assumed that for small deflections the symmetrical shape on bending is that of a spherical segment, the volume included between the originally flat disc and the flexed disc, as given by any text in solid geometry, is:

(7) $$V = \frac{\pi Y}{6}(Y^2 + 3A^2)$$

where Y is the height of the segment (the deflection) and A is the radius of the segment base (the plated disc radius). Since Y is very small as compared to A, we can neglect the Y^2 in the parentheses and we find the volume displaced under the disc to be:

(8) $$V = \frac{\pi YA^2}{2}$$

This is the volume change under a disc with a freely supported edge, as proven by mathematical analysis. Actually, because the disc is clamped at the edge (see Fig. 5), the volume change is only two thirds of this or:

(9)

$$V = \frac{\pi Y A^2}{3}$$

The proof of this is given in the mathematical appendix to this paper.

If the change in volume under the disc is this much, a similar volume change must occur in the capillary tube since the pressure causing the volume change is transmitted undiminished through the liquid to the capillary, according to Pascal's Principle. If r is the radius of the capillary and ΔL is the *change* in liquid level, then the volume change in the capillary is given by $\Delta L \pi r^2$. Equating the two, since they are equal, gives:

$$\Delta L \pi r^2 = \frac{\pi Y A^2}{3}$$

and (10)

$$\Delta L = \frac{Y A^2}{3r^2}$$

It can be seen, therefore, that ΔL, the *change* in the level of the metering fluid, is a linear measure of the deflection at the center of the disc.

The factor $A^2/3r^2$ is what the author calls the "hydraulic magnification" factor, quite analogous to the magnification produced by a hydraulic ram, except that here distance and not force is multiplied. In one such instrument the capillary has a radius of 0.025 inch and the radius of the plated disc is 1.75 inches so that the hydraulic magnification of the Stresometer is equal to

$$\frac{1.75^2}{3 \times .025^2} = 1635$$

This means that if the actual deflection at the center of the disc is 0.001 inch, it can be read on the capillary tube as a change of 1.63 inches. This hydraulic magnification, which is produced instantly and without binding of any kind, is the reason for the great sensitivity and accuracy of the instrument.

Returning to equation 6, if we solve it for S, the stress, we obtain:

(11)

$$S = \frac{A^2 Y}{4 K t h}$$

and since from equation 10, $Y = \frac{3r^2}{A^2} \Delta L$, we have by substitution:

(12)

$$S = \frac{3r^2 \Delta L}{4K t h}$$

This is the equation of the Stresometer.

Determining K, the Flexing Constant of the Stresometer

If we flex the disc by means of a known uniform pressure of say Q lbs/sq in, the fluid in the capillary will rise from its normal level to a new level and the deflection Y' at the center will be given by

$Y' = \frac{\Delta L' 3r^2}{A^2}$ where $\Delta L'$ is the change in liquid level due to Q. Since from equation 3, $Y' = KQ$, then $K = Y'/Q$, so that K, the flexing constant of the Stresometer, will be equal to

(13)

$$K = \frac{3r^2 \Delta L'}{A^2 Q}$$

Substituting this value of K back into equation 12, one obtains:

(14)

$$S = \frac{Q A^2 \Delta L}{\Delta L' 4h t}$$

This is the working equation of the instrument. It can be seen that the stress will vary directly with the change in liquid level and inversely with the thickness of the deposit.

The ratio $Q/\Delta L'$ can be obtained in several ways, but the simplest and perhaps best way is to make use of the properties of the plating solution itself. This is done by submerging the Stresometer to a fixed depth in the plating solution, which will cause the liquid in the capillary to rise, since the plating solution is then exerting a small, uniform pressure on the disc. If the specific gravity of the plating solution is G_p and the depth of submersion is i inches, the pressure on the outer face of the disc in lbs/sq in then will be equal to $0.036 G_p i$, so that $Q = .036 G_p i$. From this value and the height increase in the metering fluid on submersion of the Stresometer to the depth i, the constant for the test to be made can be determined.

Since h and A are already known, the only other factor that must be determined is t, the thickness of the deposit. Tests made on a number of specimens, using the preferred anode arrangement, show that the deposit thickness is substantially uniform, not varying by more than 1 or 2 per cent over the whole disc surface exposed to the current. This means that there is a choice of ways in which to determine the thickness of the deposit.

Determination of Deposit Thickness

The most accurate method is to weigh the disc before and after plating. This is the preferred method for research work. The thickness of the deposit, t, will be given by $t = \frac{\Delta W}{\pi A^2 G_d}$, where ΔW is the change in weight of the disc and G_d is the known density of the deposited metal.

On the other hand, in control work, where work is being done with a solution of known characteristics, if we plate the disc using a fixed current and time and a known current (cathode) efficiency, we can determine the thickness of the deposit almost as accurately as with the weight method. Here the thickness of the deposit is given by:

$$t = \frac{CITE}{\pi A^2 G_d}$$

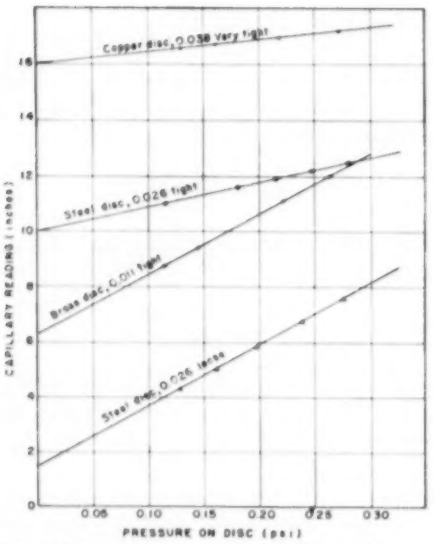
Copper disc, 0.038 very tight
Steel disc, 0.026 tight
Brass disc, 0.011 tight
Steel disc, 0.026 loose
CAPILLARY READING (inches)
PRESSURE ON DISC (psi)

Fig. 6. Variation of capillary reading with pressure on disc

where C is the electrochemical equivalent of the metal deposited, I is the total current on the disc, T is the time the disc is plated, and E is the cathode efficiency. This is probably the easiest and simplest method for thickness determination.

Alternately, but with somewhat lesser accuracy and greater time consumption, either a magnetic, microscopic, electronic, or micrometer method may be used.

Typical Test Result

The solution tested was an unpurified Watts nickel bath with a specific gravity of 1.180. A copper disc, 0.0385 inch thick, was employed for the test. The change in fluid level when the Stresometer was immersed in the plating solution to a depth of 4.50 inches was 1.00 inch. The rise in fluid level caused by the stress in the deposit was 3.30 inches. The nickel deposit was 0.00052 inch thick.

Stress in Nickel Plate =

$$\frac{0.036 \times 1.18 \times 4.5 \times 3.06 \times 3.3}{1 \times 4 \times 0.0385 \times 0.00052}$$

$= 24.1 \times 10^3$ lbs/sq in.

For the practical plater, no computations of any kind are necessary. The direct reading of the Stresometer serves as an index of the stress in the deposit. In such a case a stainless steel disc is used. Once clamped in place, it need not be removed again. The flexing constant of this disc, once determined in the regular way, need not be determined again for a long time thereafter as it will stay constant over a considerable period of time. By immersing the Stresometer to the same fixed depth in the plating solution each time a test is made and by plating at the same total current for the same total time, the thickness of the deposit does not enter into the matter and the tube reading acts as the stress index. If desired the scale may be calibrated with such indicia as "Normal," "Low," "High," and "Dangerous" stress.

After a test has been completed—which will take from ten to thirty minutes, depending on what thickness of deposit is used for the test—the reading can be recorded and the deposit stripped from the stainless steel disc in dilute nitric acid or other suitable reagent. The Stresometer is then ready for the next test. Since there is no involved preliminary procedure, no stopping off with lacquer, tests can be made easily and quickly. A simple operational control method can be established that will help in both quality control of the deposit and in the control of the bath itself (stress is usually a sensitive indicator of impurities).

Experimental Results

In working with the Stresometer a number of tests were made to check on the linearity of the relationship, $\Delta L = K'q$. These results are shown in Fig. 6, plotted as a series of curves. As can be seen for discs of copper, brass, and steel of different thicknesses, the results are straight lines, attesting to the correctness and linearity of the relationship.

Reproducibility

Typical of the results obtained with the Stresometer are four tests shown in Table I. These were made with discs of copper and steel in the thicknesses given, with an unpurified Watts nickel bath of the following composition:

$NiSO_4.7H_2O$	32 oz/gal
$NiCl_2.6H_2O$	6 oz/gal
H_3BO_3	4 oz/gal

The tests were made at room temperature (summer) because at the time they were made no constant temperature bath was available. For this reason, the stress values are somewhat higher perhaps than they would have been at 50° C. As can be seen from the table, the

TABLE I. REPRODUCIBILITY OF STRESOMETER RESULTS

Specimen Number	Disc Metal	Disc Thickness (Inches)	Deposit Thickness (Inches)	Test Temperature (C°)	Calculated* Stress (psi)
10	steel	0.0260	.00052	21.0	23.9×10^3
11	copper	0.0380	.00052	23.0	24.1×10^3
12	copper	0.0385	.00052	25.0	24.1×10^3
13	steel	0.0261	.00052	22.6	24.0×10^3

*Slide rule values, uncorrected for deposit thickness and differing moduli. Since deposit thickness is only 2 per cent or less of the disc thickness in each case, no correction has been made.

TABLE II. COMPARISON OF RESULTS WITH SPIRAL CONTRACTOMETER PURIFIED WATTS NICKEL SOLUTION (pH = 3.6)

Specimen Number	Disc Thickness (Inches)	Deposit Thickness (Inches)	Solution Temperature (C°)	Spiral Contractometer (psi)	Stresometer (psi)
16 (Copper)	0.0389	0.00017	29.15	19.5×10^3	19.4×10^3
17 (Steel)	0.0260	0.00045	27.30	18.9×10^3	18.4×10^3

variation in stress values, using discs of different materials and thicknesses, is well within the experimental error (estimated to be about 5 per cent).

Comparison With Another Method

To check on possible gross errors, results of two different tests were compared with the results obtained in the identical solution with a spiral contractometer. For this purpose the nickel solution was purified by heating with hydrogen peroxide for four hours, dummying it overnight at low current density, and finally filtering it through fine filter paper. The results are shown in Table II.

As can be seen, there is less than 3 per cent difference between the two instrument results. Because the results were so close, no further comparisons were made.

This paper is intended only to describe the Stresometer and to indicate some of its possibilities in research and control so no specific research data have been given here. However, a typical stress-thickness curve obtained with the instrument in a nickel solution, is shown in Fig. 7. This was obtained by taking readings on the instrument at regular time periods, using a fixed current. As can be seen the curve appears to follow the form previously reported in the literature on stress, there being a gradual diminishing of stress as the thickness of the deposit increases. No effort was made to corroborate the presence or absence of the minimum in the instantaneous stress curve observed by Brenner. In the same figure there is also shown a typical result for a zinc deposit from an acid type bath.

Possible Sources of Error

There are two possible sources of error in the use of the Stresometer. Fortunately their effects are either negligible or can be corrected. The first source of error is the presence of an air bubble in the metering fluid in contact with the disc. This can cause a slight error because air is compressible, and this compressibility will probably affect the capillary reading to some extent. The difficulty is completely eliminated however by carefully filling the chamber with the metering fluid, which is visible because of the Lucite construction of the instrument. The design is such that all the air travels out ahead of the liquid so that no bubbles will be trapped unless one is quite careless in the filling operation. The second source of error is temperature variation. Heat transmitted through the thin metal disc to the metering fluid causes it to expand and this expansion is registered in the capillary as an increase in height. In research work, where the solution to be tested is maintained at a constant temperature, the Stresometer will quickly come into temperature equilibrium with its surroundings and the temperature will have no effect on the readings from then on. In control work, where the Stresometer is used right in the plating bath, such close temperature control will not be available and the temperature may vary from one to five degrees during the ten to thirty minute plating interval. Fortunately, however, this does not seriously affect the final result. For example, the liquid rises 0.10 inch in the capillary for every one degree Centigrade rise. Where there is a temperature change of one or two degrees during the course of the test, the increase or decrease of 0.10 or 0.20 inch will be insignificant in comparison with the overall rise due to the plating stress, which may be in the order of 3.00 to 10.00 inches, so it can be neglected. When the temperature change comes to five degrees or more, however, it can be easily corrected for by merely adding or subtracting from the final result the temperature correction.

As an example, suppose at the start of the experiment, the temperature is 40° C and the meter reads 6.55 inches. At the end of the test, the temperature is 45° C and the meter reads 12.40 inches. If the liquid expands 0.10 inch for each degree rise then the corrected final reading will be $12.40 - 0.50 = 11.90$ inches and the overall increase will be $11.90 - 6.55 = 5.35$ inches. Accordingly, if it is suspected that there will be a temperature variation greater than five degrees during the test, a simple thermometer reading at the start and end of the test is all that is required to obtain accurate results.

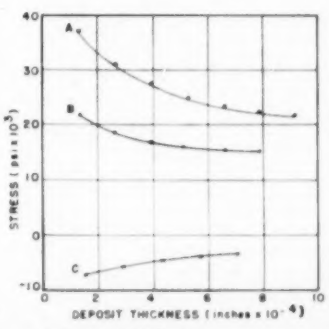

Fig. 7. Variation of stress with deposit thickness

The Stresometer cannot be used with accuracy where there are sudden and drastic temperature changes, or at a point in a plating tank close to the heat source. Sudden changes in temperature produce thermal moments on the disc that will affect the readings. Because of the high thermal conductivity of the thin metal disc these thermal moments vanish very quickly (in a few seconds). For example if the Stresometer is at room temperature and is suddenly dipped into a nickel bath at 55° C, the thermal moment will cause the disc to bulge out momentarily and the liquid will drop in the capillary. In about two or three seconds, as soon as both faces of the disc are in equilibrium, the liquid starts to rise and about thirty seconds later the liquid is at its correct equilibrium point, ready for the test.

Additional Uses of the Stresometer

The Stresometer can be used not only to determine the stress in plated deposits but in chemically made deposits, such as silver and electroless nickel and in paint and lacquer films as well. The reason for this is the extreme sensitivity of the instrument to small stresses.

Another plating use of the Stresometer is as a handy, quick, and convenient throwing power meter for testing and checking on throwing power. This is, however, outside of the scope of the present paper and will be discussed in a future presentation.

Summary

A new instrument for measuring stress in electrodeposited metals, chemically deposited metals, and paint and lacquer films has been described. It offers many advantages over the conventional stress measuring methods. No involved time consuming preparation is required to get a specimen ready for testing. No stop off paint is needed. The test specimen used, a simple metal disc, is readily mounted and removed and easily stored and filed. The instrument has high sensitivity and accuracy due to the hydraulic magnification factor, which accurately magnifies the minute deflection of the disc thousands of times so that a deflection of 0.001 inch can be read directly in inches on the scale of the instrument. There is no binding, friction, or torsion to contend with. The Stresometer can be used right in the plating tank, and the scale reading can be taken as a direct index of stress for routine control work, or it can be used in research work, where extreme accuracy and reproducibility are required. With it much basic information can be readily uncovered that will help to obtain a better picture of the nature of an electrodeposit.

Acknowledgment

The author is indebted to Professor Allison Butts, Head of the Department of Metallurgical Engineering, Lehigh University, for his permission to use in this paper some of the data from "Stress in Electrodeposited Metals and a New Method of Measurement," a thesis presented to the Graduate Faculty of Lehigh University by the author.

APPENDIX

Volume of Liquid Displaced by a Flexed Disc

Case I: Freely Supported Edge

The curve of the deflection surface of a disc subjected to a uniform load or pressure, when the edge is freely supported is given by:

$$y = \frac{qA^2(A^2 - x^2)}{16\,D\,(1-u)} = K'(A^2 - x^2) \tag{1a, 1b}$$

where K' is a constant, A is the disc radius, D is the flexural rigidity of the disc, u is Poisson's ratio, and q is the pressure on the disc per unit area.

When the portion of the curve in the first quadrant is rotated about the y axis, the volume beneath it, bounded by the original flat disc surface, will be given by: $\pi \int x^2\,dy$

But, $dy = -2K'x.dx$ so on substitution:

$$V = -2K'\pi \int_A^0 x^3.dx = \frac{\pi K'A^4}{2} \tag{2}$$

But Y, the deflection at the center, is equal to $K'A^2$ when $x = 0$ (see 1b, above). Substituting this value in 2:

$$V = \frac{\pi A^2 Y}{2} \tag{3}$$

It can be seen at once that this is the volume of a spherical segment of radius A (base), and height Y, where the height of the segment is small as compared to the radius of the base.

Case II: Disc with a Built-in Edge (Clamped)

This is the opposite extreme of Case I. Here the deflection equation is:

$$y = \frac{q}{64D}(A^2 - x^2)^2 = K''(A^2 - x^2)^2 \tag{4}$$

Proceeding as before:

$$dy = -4K''(A^2 - x^2)x.dx$$

and

$$V = -4\pi K'' \int_A^0 (A^2x^2 - x^4)dx$$

$$= \frac{4K''\pi A^6}{4} - \frac{4K''\pi A^6}{6} = \frac{K''\pi A^6}{3} = \frac{\pi A^2 Y}{3}$$

Since the deflection at the center, Y, is equal to $K''A^4$.

So,

$$V = \frac{\pi A^2 Y}{3}$$

In other words, the volume enclosed by the flexed clamped disc and the unflexed disc is equal to two-thirds of the volume of a spherical segment having the same base radius and the same height of segment.

All other cases will fall between these two extremes.

It is interesting to note, however, that since a clamped edge such as is used in the Stresometer is only approximately the equivalent of a theoretically perfect, built-in edge disc, the actual volume will lie somewhere between $\frac{\pi A^2 Y}{3}$ and $\frac{\pi A^2 Y}{2}$, which means that the hydraulic magnification is even greater than the amount estimated based on the built-in edge result.

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DISCUSSION

MR. PATTERSON: There are a few things that come to mind. The temperature of the bath will have to remain constant, otherwise the plate will form a bimetallic strip and one will have a thermometer instead of a stesometer.

MR. KUSHNER: You are absolutely correct. There is a slight thermometer effect. You must maintain the temperature within 5 degrees or better during a test. Actually, however, this temperature variation is not too serious because with the present instrument for every 10-degree change there is a difference of less than 1 inch in the reading. It is a constant that can be allowed for at all times.

In other words, in an ordinary test taken in a plating tank, where temperature control is not too close, the temperature of the bath may vary by say 3 degrees from the start to the finish of the test, so that the liquid column will move up or down a little less than 0.3 inch due to this effect. On the other hand, the stress forces during the test may cause a change in level of anywhere from 3 to 10 inches. The 0.3-inch change is negligible as compared to this large change, so that it can be disregarded for practical work.

On the other hand, for research work, if you are not already operating with a closely controlled temperature, all you have to do is make a simple correction for the expansion or contraction of the metering fluid. For example, if there is a 3-degree change during the experiment, you merely subtract the thermometer correction of 0.3 inch from the final reading if the temperature has gone up; if it has gone down, you add the 0.3 inch. The temperature effect is trivial and can be accurately corrected for at any time.

MR. PATTERSON: In the stainless steel disc, it seems to me the stress forces can be translated into shear because adhesion is poor by choice. You may have errors introduced here, too.

MR. KUSHNER: In working with a stainless steel disc it is advisable to copper flash it to insure good adhesion of the subsequent deposit. The copper flash has no effect on the final result because you measure the ΔL for the deposit you are testing only.

MR. PATTERSON: In other words, you get good adhesion to start with.

MR. KUSHNER: You must have good adhesion for the test, otherwise you are not measuring stress.

MR. PATTERSON: The third point has to do with clamping error, because you are not likely to tighten those nuts up just the same way each time.

MR. KUSHNER: The pressure and area of clamping do not enter into the picture in a given test because you determine K right in the plating bath or in water for the given test. In other words you get the K for just the way you tightened the ring. The K obtained in this way is used in the formula to give the stress in the deposited metal under test. In all cases, all you have to do is clamp the ring tight enough so that plating solution does not leak through to the metering fluid.

MR. BARRETT (Barrett Chemical Products Company, Shelton, Conn.): What is the comparative reproducibility over long periods of time between the stiff steel discs that were used and the virtually soft copper discs?

MR. KUSHNER: I did not make any extensive time tests with steel. Most of my tests were made with copper discs, with which you get excellent reproducibility. As pointed out in the paper, steel and copper discs of differing thickness gave good reproducibility when used in determining the stress in a deposit from a given Watts nickel solution at the time the tests were taken. No studies were made to determine whether the stress results for nickel deposited over steel changed with time. This could be the subject of a complete research project in itself.

MR. BARRETT: The second point is the matter concerning temperature, which was answered. But what are barometric pressure effects?

MR. KUSHNER: Barometric pressure has no effect because the tube is open on top to the air, so that you have a balancing of forces. The pressure due to the air is the same on the outside as well as the inside of the disc, so it does not come into account.

MR. CHARLES A. FORBES (Rockwell Spring and Axle Company, Coraopolis, Pa.): Are stress measurements by means of the stressometer feasible in highly agitated plating baths?

MR. KUSHNER: Yes, you can use the stresometer even in violently agitated baths for control purposes. You determine the K for the test in quiet water so you get an accurate K value, then you submerge the instrument in the tank and make your test.

STRESS EFFECT OF IRON CONTAMINATION IN A WATTS TYPE NICKEL PLATING SOLUTION AND ITS CORRELATION WITH ENDURANCE LIMIT*

L. H. CURKIN† AND R. W. MOELLER†

Introduction

Stress effect of iron contamination in a Watts type nickel plating solution has been generally recognized, but its measurement and correlation with fatigue and endurance limit has not been reported. The objectives of this investigation were to measure the stresses produced by iron contamination and to determine their correlation with changes in endurance limit as indicated by rotating beam fatigue tests.

Stress increments, resulting from additions of iron in the form of ferrous chloride to a purified nickel plating solution, were measured by two methods: (1) the Brenner-Senderoff spiral contractometer,[1] which measures stress by indicating the change in a helix during plating, from which stress may be calculated; and (2) the optical interferometer, which utilizes an optical flat in contact with the polished unplated side of the specimen to produce interference fringes. Analysis of this pattern, as recorded on a photographic negative, provides the basis for stress calculations.

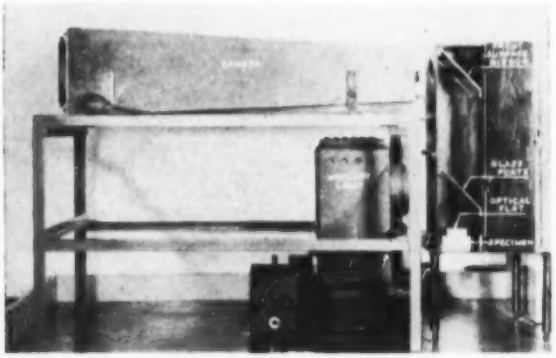

Fig. 1. Interferometer for producing and photographing interference patterns for residual stress studies

In order to utilize this optical interference principle in the adaptation originally described by H. R. Letner,[2] the apparatus shown in Fig. 1 was constructed. By measuring optical interference patterns on test pieces before and after plating, the deflection produced by plating was obtained and converted to stress measurements according to a method proposed by R. L. Mattson.[3] Degree of correlation of unit stress with fatigue and endurance limit was determined by "staircase" testing in a rotating beam fatigue test (R. R. Moore).

In this test, groups of 20 similar specimens were compared with a similar group of unplated specimens by running each specimen to failure or to run-out (10^7 cycles without failure); a predetermined increment of load above or below that of the preceding specimen was used depending upon whether that specimen ran out or failed. The mean endurance limit calculated from an average of these data represents the point at which one half of the specimens can be expected to fail.

Details of Testing

Test specimens were processed in a Watts type nickel plating solution as described below:

Solution

Nickel sulfate ($NiSO_4.6H_2O$)	24 oz/gal
Nickel chloride ($NiCl_2.6H_2O$)	17 oz/gal
Boric acid	4 oz/gal

Operating Limits

Nickel metal	8–10 oz/gal
Chloride (Cl)	4.0–6.5 oz/gal
Boric acid	3.5–4.5 oz/gal
*p*H	1.8–2.0
Temperature	120±5F

*Presented at the Forty-First Annual Convention of the American Electroplaters' Society, 13 July 1954.

†Research Chemist and Supervisor of Electrochemical Development, respectively, Materials Development Laboratory, Pratt and Whitney Aircraft, East Hartford, Connecticut.

Purification was accomplished as follows:

1. Hydrogen peroxide (4 ml per gal) was added to oxidize iron.
2. Solution was heated to 150° F and the *p*H raised to 5.5 by the addition of nickel carbonate.
3. After standing 10–12 hours, the bath was then filtered.
4. Carbon (1 oz/gal) was added and the bath agitated for 2 hours.
5. The solution was filtered.
6. The *p*H was lowered to operating range (1.8–2.0).
7. Plated at low current density (2–5 asf) on corrugated cathode for 5 ampere-hours per gallon.

Since residual stress measurements could not be made on the fatigue test specimen itself, it was necessary to measure the stress obtained by plating spiral contractometer and optical interferometer specimens before, during, and after the course of plating each group of fatigue test pieces. Contractometer helices of stainless steel were given an anodic alkali cleaning, a 15-second dip in hydrochloric acid (1 part 1.18 specific gravity acid to 1 parts water), and a 1-minute nickel strike at 50 asf prior to plating at 30 asf in the nickel plating solution.

Optical interferometer specimens, $\frac{3}{4}$ x 3 x 1/8 inches thick of AMS 6322 (SAE 8740) steel, were polished on one side to a highly reflective finish after which a reference reading of flatness was obtained. This side was then stopped off with wax, after which the opposite side was anodically alkali cleaned, immersed in hydrochloric acid, and plated at 30 asf.

Because of its direct relationship to residual stress, plate thickness per unit area was determined critically by weight difference on an analytical balance. To insure uniformity of plate thickness and prevent edge build-up on the interferometer test plates, a special fixture was used in which the $\frac{3}{4}$ x 3-inch specimen was plated while centrally located in an effective plating area $2\frac{1}{4}$ x $4\frac{1}{2}$ inches.

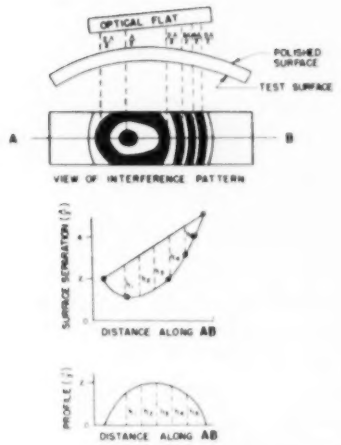

Fig. 2. Method of obtaining specimen curvature from interference pattern

R. R. Moore test specimens of AMS 6322 steel, having been hardened to Rockwell C 40, ground, and polished, were divided into random lots of 20 pieces each and were plated in groups of 5 according to a procedure similar to that used for the interferometer specimens. Average plate thickness on the gage diameter was determined on an optical comparator.

All R. R. Moore test specimens were heated in air at 375° F for three hours after plating. Test results were obtained on interferometer specimens as processed without heating and again after heating. Contractometer specimen results represent stresses obtained as plated, without subsequent heating. Interferometer specimens were examined in the apparatus shown in Fig. 1 by photographing the interference pattern obtained. From this pattern, specimen curvature was determined as depicted in Fig. 2. Stress was then calculated according to the method of R. L. Mattson.[3]

TABLE I. EFFECT OF IRON CONTENT OF PLATING BATH ON ENDURANCE LIMIT

	Endurance Limit (psi)	Reduction in Endurance Limit (psi)	Indicated Stress on Test Panel (psi)
Unplated par bar (AMS 6322, RC 40)	86,400		
Plated from Watts type solution Purified	71,200	15,200 (18%)	18,500
Plated from Watts type solution 0.2 g/l Fe^{++} added	61,300	25,100 (29%)	27,500
Plated from Watts type solution 0.4 g/l Fe^{++} added	55,200	31,200 (36%)	39,500
All specimens baked 3 hours at 375° F after plating.			

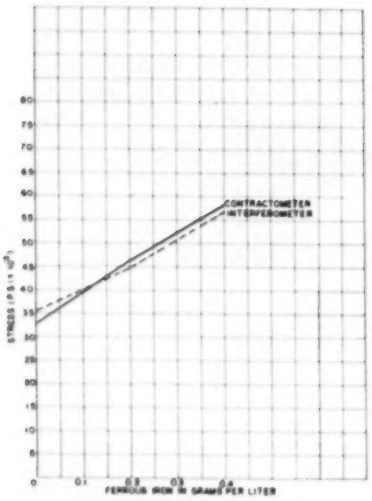

Fig. 3. Effects of ferrous iron on stress of nickel plate, as-plated

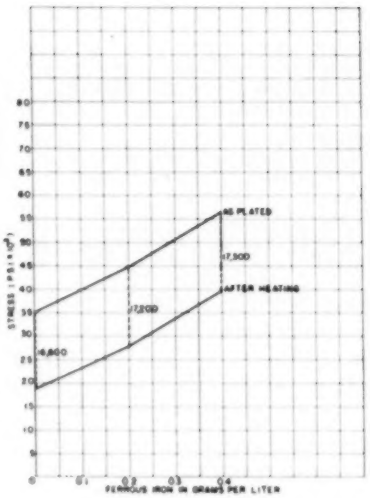

Fig. 4. Stress changes due to heating 3 hours at 375° F as measured by interferometer

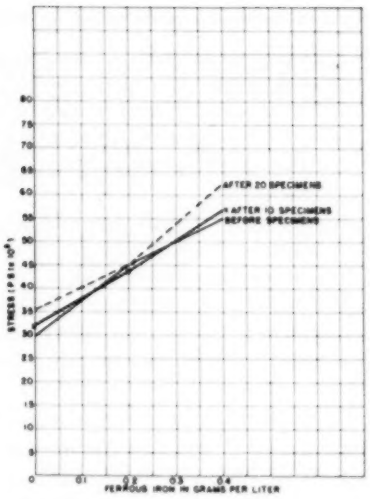

Fig. 5. Change of stress at each iron concentration level as measured by contractometer during plating of R. R. Moore specimens

Contractometer readings were observed after each helix had been plated, then converted to indicated stress according to the method described by Brenner and Senderoff.[1]

R. R. Moore rotating beam fatigue testing was conducted according to the "staircase" method, in which each specimen was run at a previously determined increment of load above or below that of the preceding specimen, depending on whether that specimen ran out or failed. If the specimen ran out, the load was increased; and if it failed the load was decreased. From these failures or run-outs an average value was obtained which is reported as mean endurance limit. The accuracy of this method is increased as the number of specimens is increased and as the load increment is decreased. Comparison with the unplated par bars tested under similar conditions gave the percentage lowering of endurance limit.

Using the par bar value as the reference figure, it can be seen from Table I that 0.0003 inch of nickel plate reduced the endurance limit.

Summary and Conclusions

The known effect of iron contamination in a Watts type nickel plating solution has been used in this investigation to produce regulated levels of residual stress in plated specimens. R. R. Moore fatigue specimens were tested to determine the correlation between

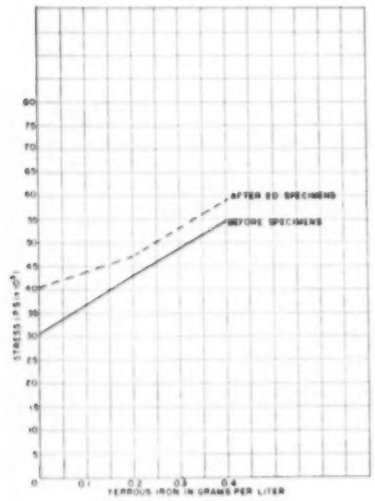

Fig. 6. Change of stress at each iron concentration level as measured by interferometer before and after plating of R. R. Moore specimens

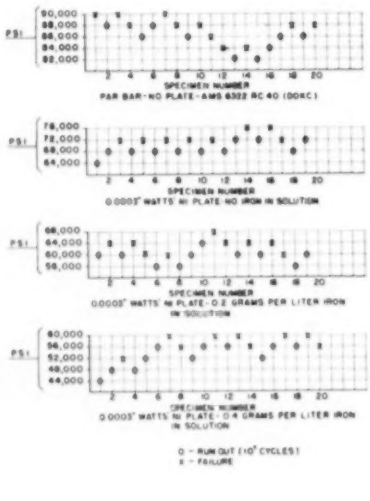
PAR BAR - NO PLATE - AMS 6302 RC 40 (DORC)
0.0003" WATTS NI PLATE NO IRON IN SOLUTION
0.0003" WATTS NI PLATE - 0.2 GRAMS PER LITER IRON IN SOLUTION
0.0003" WATTS NI PLATE - 0.4 GRAMS PER LITER IRON IN SOLUTION
SPECIMEN NUMBER
O - RUN OUT (10⁷ CYCLES)
X - FAILURE

Fig. 7. Staircase fatigue tests

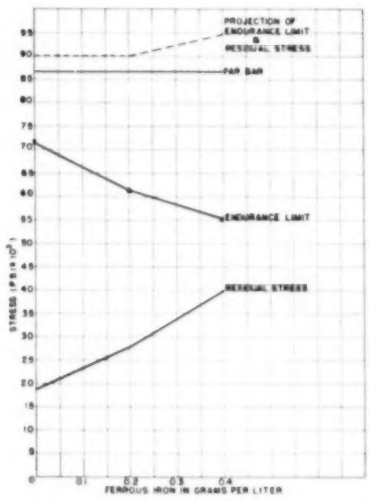

Fig. 8. Correlation of residual stress and fatigue life as measured by R. R. Moore test and interferometer

residual stress and fatigue limit, but it was necessary to process stress measurement pieces concurrently in order to measure the actual stress obtained from the solution at that time.

For this purpose two methods of measurement were used: (1) the spiral contractometer method, which is practical for indication of stress during the plating process but cannot be used to indicate the effects of heating; and (2) the optical interferometer method, which was compared with the contractometer method for the as-plated condition (Fig. 3), then used also as an acceptable method to indicate the residual stress after heating at 375° F for 3 hours. The effect of heating is shown in Fig. 4.

Twenty plated specimens were used for R. R. Moore fatigue testing at each stress level. To check constancy of plating during this period, stress measurements were made before, during, and after each group. Figures 5 and 6 illustrate the range experienced.

"Staircase" fatigue test results on these groups of R. R. Moore specimens are presented in Fig. 7, using the unplated par bars as standard of comparison. More reliable data are believed to be obtained by this method than that yielded by the standard S-N curves. Correlation of these values with stress measured on interferometer specimens is presented graphically in Fig. 8. These data indicate a residual tensile stress of 18,500 psi from purified Watts nickel plating solution, 27,500 psi with 0.2 g/l iron added, and 39,500 psi with 0.4 g/l iron added. They correlate closely with the reduction in endurance limit under corresponding conditions of 15,200 psi, 25,100 psi, and 31,200 psi.

Conversely, it can be noted in Fig. 8 that on adding the residual stress to the external or applied stress, which in this case is the reported mean endurance limit, the sum approximates the endurance limit or applied stress of the par bars, which are free from any intentional residual stress. Conceivably, an even closer correlation exists than has been shown here if the thickness of the nickel on the R. R. Moore specimens could have been determined as accurately as on the interferometer specimens.

Acknowledgments

The authors wish to acknowledge the cooperation of E. C. Reed and E. W. Ellis of the Materials Development Laboratory for their work on interferometer stress measurements and R. R. Moore fatigue testing, respectively, and to Pratt and Whitney Aircraft for permission to present this paper.

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DISCUSSION

Mr. Barrett (Barrett Chemical Products Company, Shelton, Conn.): In one of your curves, particularly after plating 20 specimens, we note an increase in residual stress, after some run-out of iron that plated out, and I cannot correlate that with the known condition of iron depletion in the bath after plating 20 specimens. Why did the residual stress rise?

Mr. Curkin: You will find that with the conditions under which we ran the test little if any iron was removed. We thought of that and by running an analysis before and after plating the specimens we came so close to the actual amount of iron that was put in that it could be entirely due to experimental error. Little or no iron is removed during the plating.

Dr. Dodd S. Carr (Bart Laboratories Company, Inc., Belleville, N. J.): I would like to know what type of antipitting agent you used in the plating solution?

Mr. Curkin: In that plating solution? None.

Dr. Carr: I was going to say that if you used a wetting agent the increase in stress after 20 specimens may have been due to breakdown products of wetting agents.

Mr. Curkin: We found that an increased agitation eliminated all pitting, so that when we started anew the second time through the experiment, we made sure we had that increased agitation all the way and were not bothered with pitting.

Dr. Carr: Was there any particular reason for choosing such a high chloride plating bath?

Mr. Curkin: We have been using this type for a reason that has never been told to me.

Dr. Carr: It appears that the stress in your purified solution was almost double that found in a low chloride Watts bath, so it would seem that a simple way to reduce stress rather than purifying iron would be simply to cut down the amount of chloride you have in the bath.

Mr. Curkin: After giving it a standard bake, which is considered necessary for a nickel plate, you notice it is down to around 15,000 psi.

Dr. Carr: What would it be if you started at half the original stress?

Mr. Curkin: Probably half the original stress.

Dr. Carr: The reason for the high chloride content is probably to improve anode corrosion in the plating bath; but if the ultimate aim is low stress in the product, I would say it would be desirable not to run as high a chloride content in the plating bath. What happens if you heat the nickel to higher temperatures than 375° F?

Mr. Curkin: We have not run that because all our specifications call for 375° F bake.

Mr. Leland M. Morse (Chrysler Corporation, Detroit, Mich.): In what form would you say that iron was present in the nickel solution, ferrous or ferric?

Mr. Curkin: We added it as ferrous chloride.

Mr. Morse: Don't you think the increase in stress over the period of running those samples was probably due to change from ferrous to ferric form?

MR. CURKIN: That could possibly be. We have found that, with no contamination at all, in running 20 specimens along with the contractometer and the interferometer specimen the first group of 5 always has a lower residual stress than the final group.

MR. MOELLER (coauthor of paper under discussion): I have a comment here rather than a question. I imagine that many people here are wondering why, after the advantages that were extolled for the sulfumate bath, we are still working with a Watts bath. We have a number of different applications, a number of different temperatures involved. You would probably be surprised to find that some of our temperature applications in jet engines on plated parts run up to 600, 700, 800, 900. We were working on parts and testing them at 1600.

There are certain advantages to each bath. In this case we are determining stress rather than trying to find out whether this is the particular plate to use in all applications. We are using some sulfamate nickel, as was indicated in the paper. We are also using Watts nickel in other applications.

DR. CARR: After you once had proven the accuracy of the contractometer against the interferometer, did you still find it necessary to continue your stress readings in each instance?

MR. CURKIN: We did for the simple reason that two figures are always better than one.

DR. CARR: You had 20 specimens, you ran stress determination for each specimen?

MR. CURKIN: No, they were plated in groups of 5.

DR. CARR: And the stress was determined on completion of the plating cycle?

MR. CURKIN: The stress was taken before—after 10 specimens and after 20 specimens.

DR. CARR: What effect would oxide films have on interference patterns in the optical method—do you have any idea?

MR. CURKIN: According to the gentleman who ran it, it has to be perfectly flat and very highly reflective. They used 2 inches of the 3 inches on the back of the specimen, so that if they did get an oxide film in one section, by eliminating that section, they still had plenty of room for calculations. Naturally, the better the condition of the specimen, the better the calculations.

DR. CARR: Would you say it was a highly buffed surface, but that it was protected during the plating cycle?

MR. CURKIN: Yes, that is right, it was the back part of the plated specimen.

DR. CARR: Was electrical contact made on the front?

MR. CURKIN: No, we made contact from the ends and sides. We had a groove, the width of the specimen, cut into the 2¼x1½ inch block. The specimen was placed into this groove and tightened on the ends and sides. The entire fixture and specimen was then waxed over, so that the only part exposed was the side to be plated.

* * *

Magic eye enables pipeline men to look into a pipe and tell what is passing through. Called a capacitance recorder, the instrument offers a continuous check on pipeline contents and even differentiates between two grades of the same fluid. Developed by Gulf Oil Corporation's research laboratories, the device functions by revealing variations in the electrical properties of fluids as they pass between two electrodes fixed within the pipe. Changes are recorded on a clock-driven chart and appear as variations on the chart.

* * *

Progress vanishes when contentment strikes. Fortunately, one of this country's greatest assets is a deep unrest and search for knowledge. Those qualities, which have resulted in the tremendous changes of the past few decades, are sparked by applied industrial research and technological schools that supply manpower for that researach.

* * *

"Stacked" electron tube is said to be stable under extreme temperature, vibration, and shock, according to Sylvania Research Laboratories, where it was developed for military use. The tube features a ceramic cap instead of the usual glass bulb, inside of which various parts are stacked on top of each other during assembly to provide ruggedness.

* * *

Light-weight titanium alloy, considered suitable to replace steel in military weapons, has been developed for the Ordnance Corps. Use of the alloy in heavy weapons and tanks would increase their mobility, say Armour Research Foundations engineers, who developed it.

* * *

Back of our plants, back of the people who build and operate them, are our research laboratories, and they are perhaps our greatest single resource. Every new product, every improvement in process, every advance in technology, had its beginning somewhere, somehow, in the mind of a research worker in his laboratory. Research is the essential vitamin without which the body of industry loses its vitality and dynamic character.

COPPER-TIN ALLOY PLATING*

W. H. SAFRANEK† AND C. L. FAUST†

Abstract

Copper-tin alloy plates in the composition range of 17 to about 50 per cent tin, the balance copper, exhibited several outstanding properties. Two important properties were good leveling and good protection against corrosion. Bronze plus a thin nickel plate performed better than thick nickel plate in outdoor weathering tests in a marine atmosphere and was at least as good as nickel plate in an industrial atmosphere. Bronze plus chromium was greatly superior to copper plus chromium. Because of its good performance, bronze alloy is being considered seriously as a replacement for nickel plate.

Alloy plate that smoothens rough basis metal surfaces as much as 40 to 66 per cent per 0.001 inch of plate can be deposited from the pyrophosphate bath. The tin content and other conditions affect the leveling power. The combination of good leveling and good corrosion protection makes copper-tin alloy plates attractive for many decorative applications. An unusual tolerance for metallic impurities and outstanding throwing power are important features of the plating baths.

Plating Baths

Two baths have been developed for plating copper-tin alloys. One is a solution of copper cyanide and stannous pyrophosphate,[1] recently improved with additives that promote dissolution of alloy anodes and brighten the plate.[2] The other is comprised principally of copper cyanide and sodium stannate.[3] Representative bath formulations are given in Table I.

Both baths exhibit excellent throwing power but differ greatly in other respects. Plates deposited in the copper cyanide-sodium stannate bath are generally dull and relatively hard to buff. Brighteners were investigated[4] with the conclusion that none were satisfactory for commercial operation. Separate copper and tin anodes are used with separate anode circuits for the stannate bath,[5] or copper or tin anodes are installed alternatively for short periods.[6] The tin anodes must be carefully "filmed" to avoid the formation of stannous tin, which is harmful in the bath and causes spongelike deposits.

Bright plates are produced in the pyrophosphate bath. Cast alloy anodes supply the copper and tin at the same rate and in the same ratio that they are required for deposition. The tin dissolves in the stannous form. No harm results if the stannous tin is oxidized to the stannic state. The pyrophosphate bath is easier to control and less sensitive to impurities than the stannate solution. Less cyanide is consumed in the pyrophosphate bath, and the plating rate is faster. Other characteristics are given in Table II.

Alloy Composition

Speculum alloy containing 50 to 60 per cent copper and 40 to 50 per cent tin is a silverlike white metal

TABLE I. BATH FORMULATIONS FOR PLATING COPPER-TIN (SPECULUM) ALLOY

Copper Cyanide-Sodium Stannate Bath
Sodium stannate, 100 g/l (13.4 oz/gal)
Sodium cyanide, 28.5 g/l (3.8 oz/gal)
Copper cyanide, 11.5 g/l (1.52 oz/gal)
Sodium hydroxide, 10 g/l (1.34 oz/gal)
Free sodium cyanide, 16 g/l (2.25 oz/gal)
Free sodium hydroxide, 15 g/l (2.0 oz/gal)
Copper: tin ratio, 0.2
Copper Cyanide-Stannous Pyrophosphate Bath
Stannous pyrophosphate, 12 g/l (1.6 oz/gal)
Potassium cyanide, 50 g/l (6.7 oz/gal)
Copper cyanide, 20 g/l (2.7 oz/gal)
Potassium pyrophosphate, 100 g/l (13.4 oz/gal)
Addition agent, 1 g/l (0.13 oz/gal)
Free potassium cyanide, 7.5 g/l (1.0 oz/gal)
*p*H, 9.5
Copper: tin ratio, 2.8

*Presented at the Forty-First Annual Convention of the American Electroplaters' Society, 13 July, 1954.

†Assistant Chief and Chief, respectively, Electrochemical Engineering Division, Battelle Memorial Institute, Columbus, Ohio.

TABLE II. CHARACTERISTICS OF COPPER-TIN ALLOY PLATING BATHS

Characteristic	Cyanide-Stannate Bath	Cyanide-Pyrophosphate Bath
Appearance of plates	Dull	Bright
Cathode current density, asf	15 to 25	20 to 70
Cathode efficiency, per cent	50 to 60, based on Sn^{4+} and Cu^{+}	50 to 70, based on Sn^{2+} and Cu^{+}
Rate of deposition, in/hr	0.001 to 0.0025	0.002 to 0.005
Anodes	Copper and tin with separate anode circuits	Copper-tin alloy
Anode current density, asf	15 to 20 for tin anodes 5 to 10 for copper anodes	5 to 20
Anode bagging or diaphragming	Not required for thin plates	Not required; diaphragms recommended for 0.0015-inch, or thicker, plates that are not buffed
Temperature, F	150	140 to 180
Tank voltage	2 to 4	2 to 5
Filtration	Occasional batch treatment	Occasional batch treatment or continuous
Cyanide consumption, g/l/day	3 to 4	0.5 to 1.0
Caustic consumption, g/l/day	4 to 5	None
Important control features	Free cyanide concentration; free caustic concentration; copper: tin ratio and anode current density	Free cyanide concentration; anode current density
Effects of impurities	Stannous tin causes spongelike deposit; nickel and cobalt greatly reduce the cathode efficiency; lead and antimony reduce the ductility of the plate; oil or grease causes pitting	Neither stannous nor stannic tin are harmful; nickel and antimony cause dark spongelike deposits; lead reduces the ductility of the plate; calcium, magnesium, iron, and zinc are not harmful; oil and grease cause pitting

that is four times as hard as silver (400 to 420 Knoop compared with 70 to 120 Knoop). It is more resistant to tarnishing than silver or nickel. Thus, its reflective power, initially about 5 per cent less than freshly buffed silver, is changed only slightly by normal atmospheric conditions, and after weeks or months of service the reflectivity of speculum is greatly superior to the reflectivity of silver and nickel. Speculum alloy is relatively nonductile, regardless of the conditions used for depositing it. Microscopic structures are illustrated in Figs. 1 and 2. X-ray studies of the bright plate deposited in the pyrophosphate bath revealed that the grain size was less than 10^{-6} cm. The bright alloy is highly oriented with (110) crystal planes parallel to the basis metal surface. By comparison, dull plates deposited in the stannate bath are randomly oriented. Speculum plates are used for reflectors, tableware, and hardware.

Bronze alloy containing 80 to 83 per cent copper and 20 to 17 per cent tin has a golden-red color and a hardness of 300 to 320 Knoop (about three times as hard as copper). The plate deposited in the pyrophosphate bath on buffed zinc die castings is bright. It is very lowly stressed, to the extent of 2,000 psi in tension, according to measurements with the Brenner-Senderoff Contractometer.[7] The microscopic structure of this bronze alloy is similar to that shown in Fig. 1. Bronze alloy is used for decorative and protective plating, as an undercoat for tin, chromium, or nickel plus chromium.

Bronze alloy containing 7 to 10 per cent tin has a hardness of 260 to 280 Knoop (nearly three times as hard as copper plate). In ductility, it is about the equal of ductile copper. This bronze alloy exhibits a columnar structure much like copper deposited in acid baths with molasses as an addition agent. Plates from the stannate and the pyrophosphate baths are dull, but the plates from the pyrophosphate bath are much easier to buff. Electropolishing[8] brightens such plate in 3 or 4 minutes. Bronze plates are lowly stressed, being in the range of 6,500 to 11,500 psi, in tension. This bronze alloy is used for decorative purposes and for protective purposes under lacquer, tin plate, chromium plate, or nickel plus chromium plates. It is an efficient stop off against surface hardening by nitriding.[9,10] Worn and mismachined parts are rebuilt to size with bronze alloy. Bronze plate containing 7 per cent tin displays good bearing properties.[11]

Bronze alloy containing up to 20 per cent tin is adherently plated directly on steel, zinc die castings, and lead alloys, following conventional cleaning procedures. The bronze plate is advantageous as an undercoat for nickel-tin alloy plating or speculum plating.

Throwing Power

The throwing power of the pyrophosphate bronze plating bath is superior to the throwing power of cop-

per cyanide baths and is at least equal to the throwing power of the stannate tin bath. An unusually difficult problem dealing with plating the bore surface of 1-inch long sections of very small diameter, thin-walled tubing was solved by bronze plating. The ID and the OD of the tubing were 0.020 and 0.030 inch. The minimum thickness on the bore surface after 8 minutes of bronze plating was 0.0005 inch, whereas only 0.0003 inch of copper was deposited during 15 minutes of plating in a cyanide bath. Furthermore, the bronze was smoother than the copper plate, both on the inside and outside surfaces. By comparison, only about 0.0002 inch of nickel was deposited by the electroless nickel process during 2 hours.

Leveling

Bronze and speculum plates deposited in the pyrophosphate bath display good leveling power. The degree of leveling or scratch filling provided by the plate depends on its thickness and the tin content of the alloy deposit. The leveling power of bronze alloy plate containing 17 to 20 per cent tin is comparable with the leveling power of semibright nickel plating. For example, one area of a bumper guard with a finish of 14 to 18 rms microinch was smoothened to between 8 and 11 rms microinches by plating 0.00075 inch of such bronze alloy. The roughness in another area measuring 19 to 26 rms microinches was reduced to between 12 and 17 rms microinches. Supplementary data on other bumper guards were as follows:

Roughness Measurements on Polished Steel Bumper Guards (rms microinches)	Roughness Measurements after Bronze Plating (rms microinches)	Approximate Thickness of Bronze Plate (inch)
29 to 37	18 to 23	0.00075
33 to 40	15 to 22	0.001
27 to 32	13 to 20	0.001
21 to 25	11 to 14	0.001
26 to 31	13 to 18	0.001

The bronze plated bumper guards, buffed and plated with 0.0005 inch of bright nickel and chromium, had a better scratch appearance than copper plated and buffed bumper guards after bright nickel and chromium plating as a result of the superior leveling power of the bronze plate by comparison with the copper plate. Fig. 3 shows the good scratch-filling property of the bronze alloy.

Speculum alloy containing 45 per cent tin and 55 per cent copper fills irregularities in the basis metal surface better than bronze plate. For example, a 21 rms microinch finish on steel, obtained by polishing with 80, 120, and 180 grit abrasive material, was reduced to only 7 rms microinches by plating 0.001 inch of the speculum alloy.

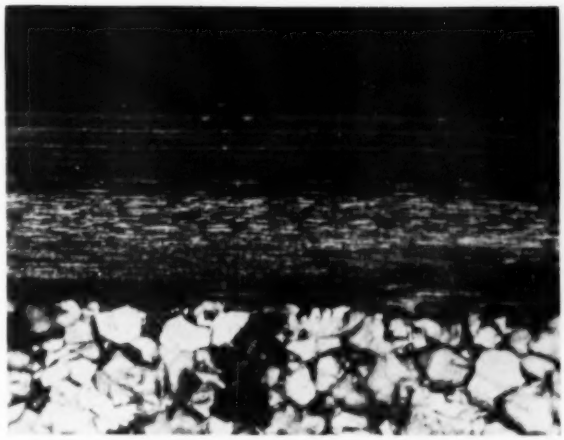


Fig. 1. Cross section of speculum plate over steel. Speculum alloy was deposited in the pyrophosphate bath. 800 X

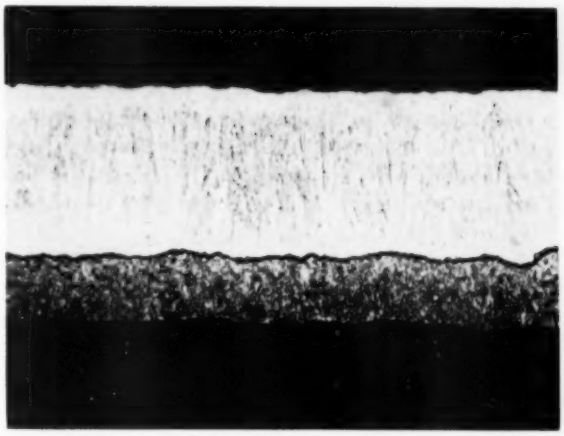
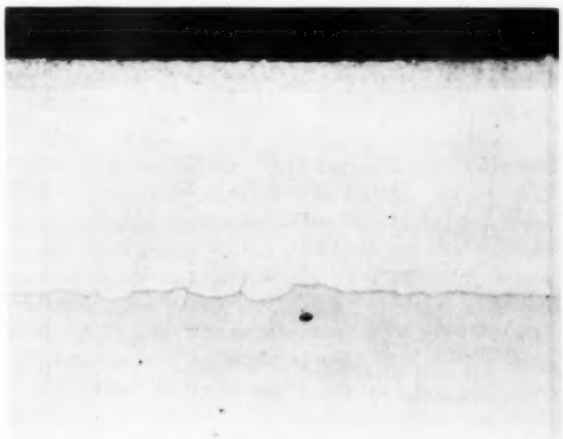


Fig. 2. Cross section of speculum plate over copper plated zinc die casting. Speculum alloy was deposited in the stannate bath. 800 X



Courtesy of Standard Steel Spring Division, Rockwell Spring and Axle Company

Fig. 3. Photomicrograph of 0.003 inch bronze electroplate on polished steel. 500 X

TABLE III. LEVELING DATA ON COPPER-TIN ALLOY PLATES

Tin Content of Alloy Plate* (per cent)	Thickness (inch)	Agitation Stroke† (inches)	Profilometer Measurements, rms microinches	
			Steel	Plate
10	0.0012	4	19–24	18–23
20	0.0009	None	16–22	15–20
20	0.0009	1½	18–25	11–17
20	0.0010	2	16–21	11–17
20	0.00083	2½	22–30	16–20
20	0.0008	4	19–26	12–17
30	0.0011	4	32–35	20–23
40	0.0012	4	26–29	18–21
50	0.0008	4	28–32	20–22

*Copper-tin alloy plates deposited in the cyanide-pyrophosphate bath on polished steel panels.
†Panels were moved back and forth at 20 cpm.

Agitation influences the leveling power of bronze and speculum alloy plates. With work-bar agitation and a 4-inch stroke, good leveling is obtained consistently. The copper-tin alloy plates accomplish very little leveling with no agitation. Representative leveling data on bronze and speculum alloy plates are listed in Table III.

Bronze alloy containing only 10 per cent tin furnishes little or no leveling that can be detected by surface-profile measurements, regardless of the conditions used for depositing the alloy. Yet polished steel plated with 0.0005 to 0.001 inch of this alloy has a good scratch appearance after the plate is buffed. The plate deposited in the cyanide-pyrophosphate bath is relatively easy to buff.

Thick deposits of the 10 per cent tin-bronze alloy, up to at least 0.025 inch, are made smoother by using periodic current reversal. A PR cycle consisting of 5 seconds of direct plating and 1 second of reversal gives good results. PR also improves the bright plating range of the speculum alloy.

Salt-Spray Data

Bronze and speculum plates were better than copper and nickel plates in salt spray tests conforming to ASTM Tentative Method B-117-49T.[12] Steel panels,

TABLE IV. RESULTS OF ACETIC ACID SALT SPRAY TESTS ON BRONZE PLUS BRIGHT NICKEL PLUS CHROMIUM PLATED BUMPER GUARDS*

Bumper Guard No.	Tin Content of Alloy Plate (per cent)	Minimum Thickness after Buffing (inch)	Results of Salt Spray Testing, Number of Rust Spots after†		
			23 hours	47 hours	71 hours
2	20	0.00113	None	0	3
4	20	0.00071	None	21	47
5	20	0.00112	1	5	21
6	20	0.00090	4	44	71
8	20	0.00138	2	9	28
13	10	0.00121	12	56	93
14	10	0.00119	4	9	30
Average	—	0.00110	3.3	20.6	39.1
Average for 20 per cent tin bronze	—	0.00105	1.4	15.8	31.0
Average for 10 per cent tin bronze	—	0.00122	8.0	32.5	61.5

*Identity of the company that carried out the nickel plating (0.0005 to 0.0006 inch thick), the chromium plating, and the salt spray testing will be supplied on request.
†Salt solution consisted of 5 per cent sodium chloride with the *p*H adjusted to 3.5 with acetic acid. Rust spots were approximately 1/64 inch in diameter or less.

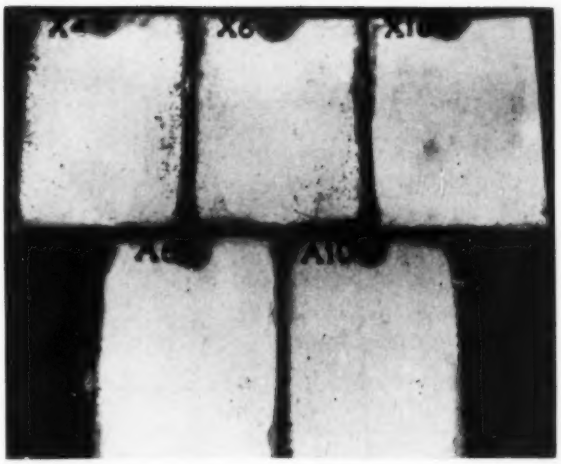


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Fig. 4. Bronze and chromium plated steel panels exposed at Pittsburgh, Pennsylvania, from 1 October 1953 to 21 June 1954

X4—0.0013 inch bronze plus 0.00001 inch chromium
X6—0.0016 inch bronze plus 0.00001 inch chromium
X16—0.0017 inch bronze plus 0.00001 inch chromium
A6—0.0023 inch bronze plus 0.00001 inch chromium
A10—0.0020 inch bronze plus 0.00001 inch chromium

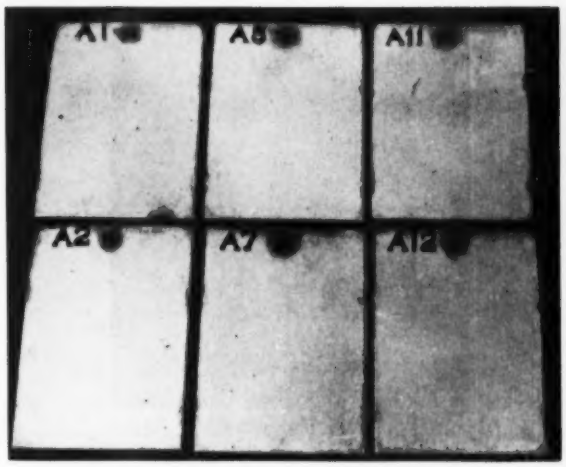

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Fig. 5. Bronze, nickel (semibright), and chromium plated steel panels exposed at Pittsburgh, Pennsylvania, from 1 October 1953 to 21 June 1954

A1—0.0008 inch bronze plus 0.0003 inch nickel plus 0.00001 inch chromium
A5—0.0009 inch bronze plus 0.0003 inch nickel plus 0.00001 inch chromium
A11—0.0015 inch bronze plus 0.0003 inch nickel plus 0.00001 inch chromium
A2—0.0015 inch bronze plus 0.0003 inch nickel plus 0.00001 inch chromium
A7—0.0020 inch bronze plus 0.0003 inch nickel plus 0.00001 inch chromium
A12—0.0020 inch bronze plus 0.0003 inch nickel plus 0.00001 inch chromium

plated with only 0.0005 inch of bronze alloy plus 0.00002 inch of chromium, showed scarcely any rust after 72 hours of salt spray testing. Another set of steel panels plated with 0.001 inch of bright nickel plus 0.0002 inch of chromium acquired many rust spots during 48 hours in the salt spray test. Speculum alloy plate, 0.001 inch thick with no chromium overlay, furnished about the same protection as the bronze plus chromium plates. Copper, 0.0007 inch thick plus chromium, and copper, 0.0007 inch thick plus 0.00015 inch of nickel plus chromium, were inferior to the speculum or the nickel plus chromium plates.

The acetic acid modified salt spray fog, considered three times as severe as the sodium chloride fog, also demonstrated the superiority of bronze plus nickel plus chromium plates over copper plus nickel plus chromium plates. The bronze alloy containing 20 per cent tin provided better protection than the bronze alloy containing 10 per cent tin. Table IV details the results of the acetic acid salt spray test on bumper guards plated with bronze, bright nickel, and chromium. By comparison, other bumper guards plated with copper, bright nickel, and chromium acquired two to three times as many rust spots.

Weather Exposure Tests

Weather exposure data reported previously[12] demonstrated that bronze was superior to copper for protecting steel from corrosion. Furthermore, bronze plate with a decorative chromium overlay did not discolor as did copper plus chromium plate in the outdoor exposure test at Daytona Beach, Florida. Steel panels plated with only 0.0005 inch of bronze plus 0.00001 inch of chromium exposed for 5 months had a better appearance than another set of panels plated with 0.001 inch of copper, 0.00005 inch of bright nickel, and 0.00001 inch of chromium after exposure for only 3 months. The bronze plate contained 17 to 20 per cent tin.

Recent tests indicate that bronze plus chromium plate is nearly the equal of nickel plate. Bronze plus nickel and chromium was better than nickel and chromium. Steel panels plated with bronze and chromium exposed outdoors continuously at Pittsburgh, Pennsylvania, from 1 October 1953 to 21 June 1954 are shown in Fig. 4. The bronze was buffed prior to chromium plating. Panels plated with bronze plus semibright nickel and chromium exposed for the same period are pictured in Fig. 5. The nickel was buffed, but not the bronze plate. For comparison, buffed nickel plus chromium plates were tested at the same time. They are shown in Fig. 6. None of the panels were cleaned at any time during the 12-week exposure period.

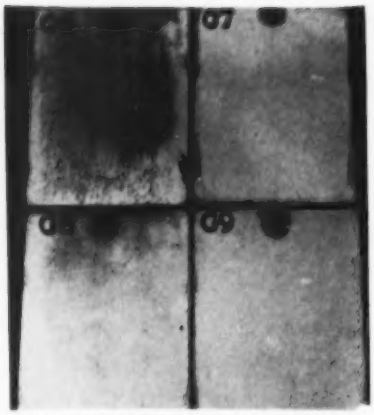

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Fig. 6. Buffed nickel and chromium plated steel panels exposed at Pittsburgh, Pennsylvania, from 1 October 1953 to 21 June 1954
G3—0.0014 inch nickel plus 0.00001 inch chromium
G7—0.0016 inch nickel plus 0.00001 inch chromium
G8—0.0025 inch nickel plus 0.00001 inch chromium
G9—0.0025 inch nickel plus 0.00001 inch chromium

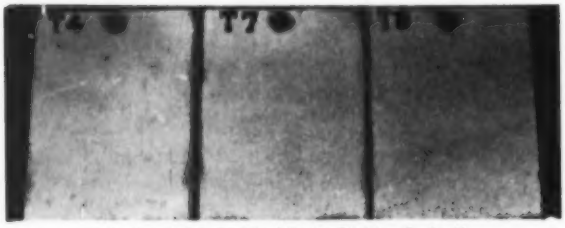

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Fig. 7. Bronze, bright nickel, and chromium plated steel panels exposed at Pittsburgh, Pennsylvania, from 1 January to 21 June 1954
T4, T7, and T8—0.001 inch bronze plus 0.0002 inch bright nickel plus 0.00002 inch chromium

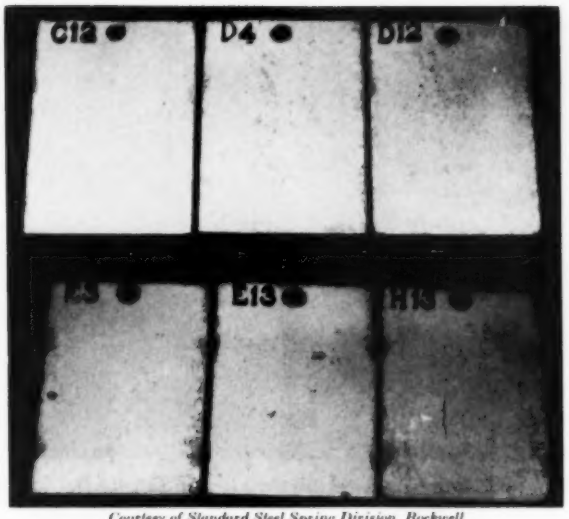

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Fig. 8. Bright nickel and chromium plated steel panels exposed at Pittsburgh, Pennsylvania, from 1 January to 21 June 1954
C12, D4, D12, E3, E13, and H13—0.001 to 0.0012 inch bright nickel plus 0.00002 inch chromium

The defects apparent after 9 months of exposure were as follows:

Buffed nickel plus chromium	Slight to intermediate pinpoint rusting, intermediate rust stain
Bronze plus nickel (buffed), plus chromium	Intermediate pinpoint rusting, intermediate rust stain
Buffed bronze plus chromium	Slight pinpoint rusting, intermediate rust stain, slight blistering, especially at edges (chromium from bronze)

TABLE V. RESULTS OF EXPOSING BRONZE PLATED STEEL PANELS OUTDOORS FROM ABOUT 1 JANUARY TO 30 JUNE 1954*

Description of Plate	Results of Exposure at Location Given		
	Columbus, Ohio	Daytona Beach, Florida	Pittsburgh, Pennsylvania
Bronze, 0.001 inch; plus bright nickel, 0.0002 inch; plus chromium; 0.00001 to 0.00002 inch	No rust or stain	Very slight to slight rust stain	Very slight pinpoint rusting (5 to 10 pinpoints per panel)
Bright nickel, 0.001 to 0.0012 inch; plus chromium, 0.00001 to 0.00002 inch	Slight pinpoint rusting (10 to 25 pinpoints per panel)	Much rusting (up to 400 rust spots and intermediate rust stain)	Intermediate pinpoint rusting (20 to 50 pinpoints per panel)

*The 1/8 x 4 x 6-inch steel panels were sheared from flat polished steel sheets. The surface finish before plating was in the range of 12 to 20 rms microinches. At least four and up to eight bronze plated panels were exposed at each test site. Twelve nickel plated panels were exposed at each site. The tin content of the bronze plate was in the range of 17 to 20 per cent.

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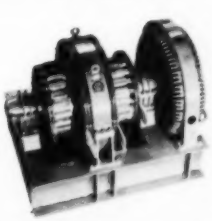

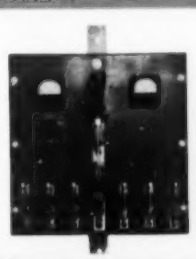

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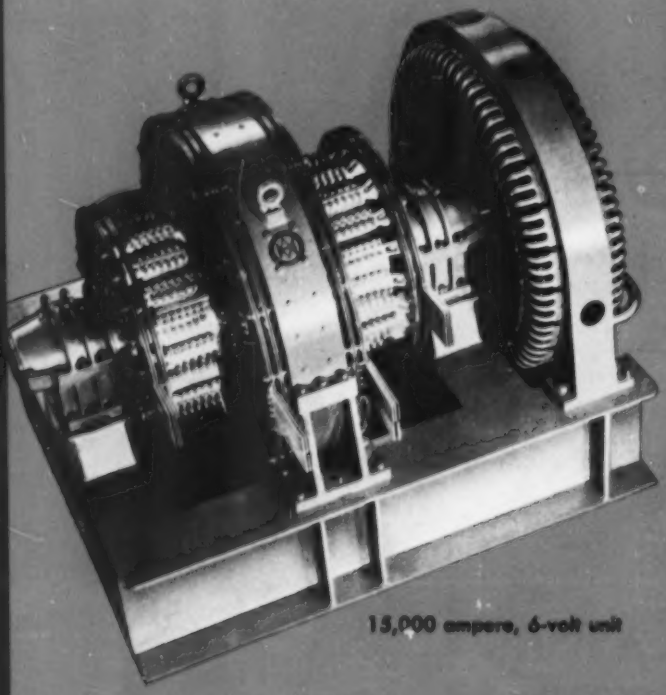

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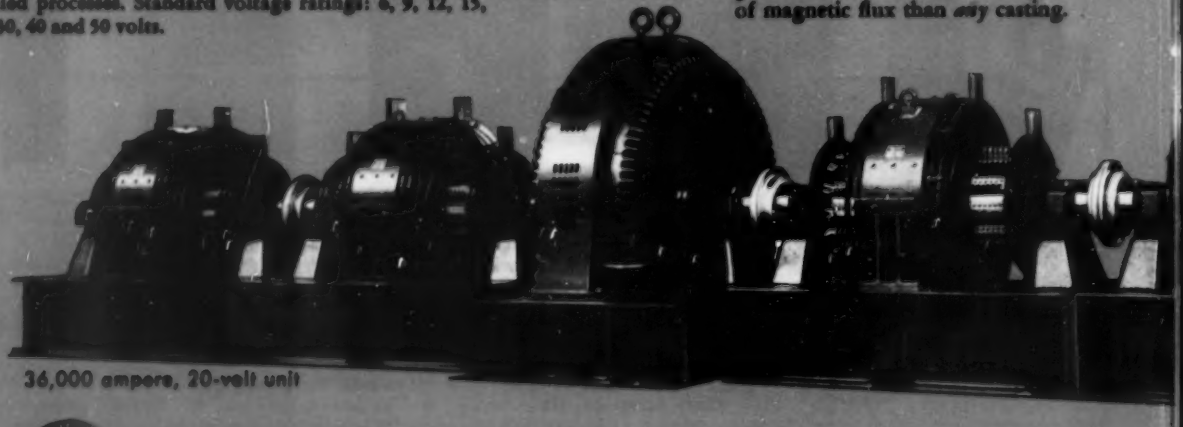

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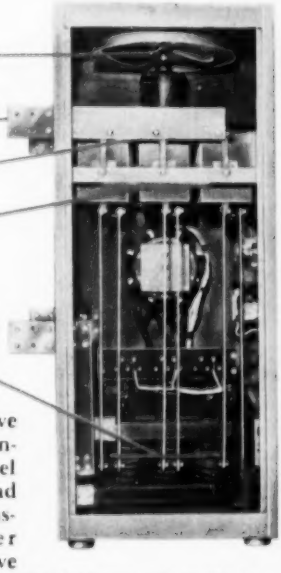

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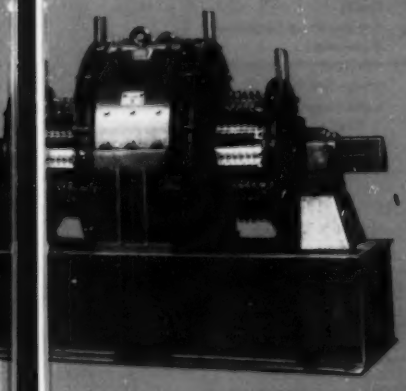

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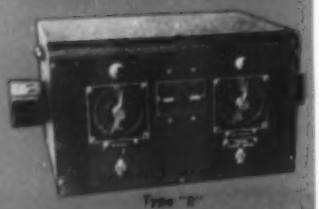

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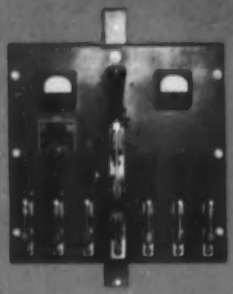

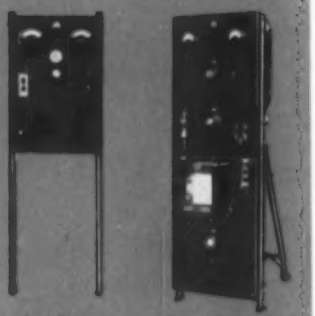

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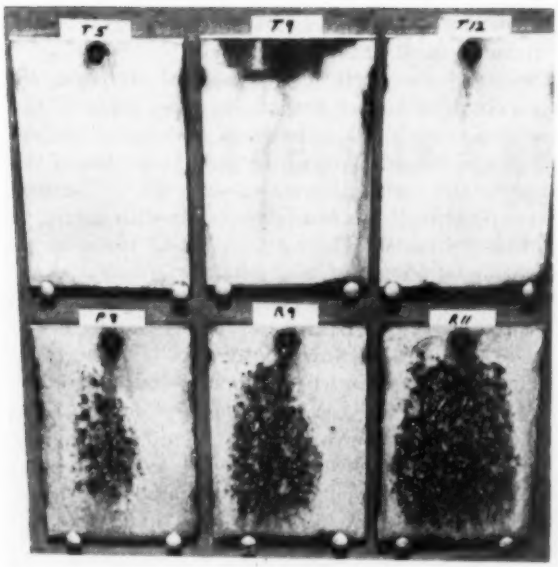

Fig. 9. Steel panels exposed at Daytona Beach, Florida, from 1 January to 15 June 1954
T5, T9, and T12—0.001 inch bronze plus 0.0002 inch bright nickel plus 0.00001 inch chromium
P8, R9, and R11—0.001 to 0.0012 inch plus bright nickel plus 0.00001 inch chromium

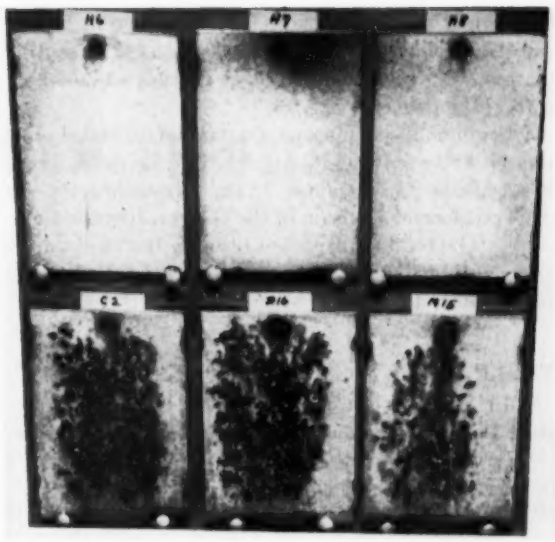

Fig. 10. Steel panels exposed at Daytona Beach, Florida, from 1 January to 15 June 1954
H6, H7, and H8—0.001 inch bronze plus 0.0002 inch bright nickel plus 0.00001 inch chromium
C2, D16, and M15—0.001 to 0.0012 inch bright nickel plus 0.00001 inch chromium

The cause for the blistering of the chromium from the bronze plate was not determined. Bronze plus chromium plated panels exposed previously at Daytona Beach, Florida, did not show blistering after 5 months of exposure.

Another set of polished steel panels plated with bronze containing 10 per cent tin plus nickel and/or chromium were corroded more than the panels plated with bronze alloy containing 20 per cent tin. Thus it can be concluded that bronze with a 20 per cent tin content furnished better protection for steel than bronze with a 10 per cent tin content. The superior leveling power of the bronze with 20 per cent tin alloy probably favors the corrosion protection provided by the plate.

Bronze plus bright nickel and chromium was compared with bright nickel and chromium at three testing sites. The results, summarized in Table V, show that the bronze plus nickel and chromium plates were consistently better than the nickel and chromium plates. About half of the bronze plates were buffed. The buffing improved the appearance of the panels but did not appear to influence the protection furnished by the bronze plate. Bronze plus nickel and chromium plated panels exposed for 24 weeks at Pittsburgh, Pennsylvania, are shown in Fig. 7. The bright nickel plated panels exposed there at the same time are pictured in Fig. 8. Panels plated with bronze plus bright nickel plus chromium and exposed at Daytona Beach, Florida, were much less corroded than panels plated

TABLE VI. COMPARISON OF SPECULUM WITH ZINC AND NICKEL PLATES ON STEEL IN OUTDOOR WEATHERING TESTS FOR 4 YEARS AND 9 MONTHS

Location	Speculum Plate (0.0005 inch)	Nickel Plate (0.0005 inch)	Zinc Plate (0.0005 inch)
Pittsfield (rural atmosphere)	Excellent	Good	Fair to good
Pittsburgh (industrial atmosphere)	Good	Poor to fair	Poor to fair
Lynn (marine atmosphere)	Poor to good	Good	Fair to good

with bright nickel and chromium, as shown in Figs. 9 and 10. One bright nickel process was used for plating the panels in Fig. 9, and another process was used for plating the panels in Fig. 10.

Speculum alloy plate was compared with nickel plate and with zinc plate at Pittsburgh, Pennsylvania; Pittsfield, Massachusetts; and Lynn, Massachusetts, by the Transformer Division of the General Electric Company. The outdoor exposure tests on the steel panels were continued for 4 years and 9 months; the results are given in Table VI.[13]

TABLE VII. WEIGHT-LOSS DATA ON SPECULUM AND NICKEL PLATES ON STEEL

Nickel Plated Steel (0.0005 inch nickel)	
Number of Days Exposure	Weight Loss (mg/sq dm)
295	225
684	396
1172	633
Speculum Plated Steel (0.0005 inch speculum)	
Number of Days Exposure	Weight Loss (mg/sq dm)
372	1
759	86
1729	157

Typical quantitative measurements of weight loss at Pittsburgh are detailed in Table VII.

Several commercial installations of the cyanide-pyrophosphate bronze baths have been made in the past two years to take advantage of the good characteristics of the process and the good properties of the deposit. One installation is two years old.[11] Commercial experience shows favorable results with regard to control and costs. The costs are about the same as bright nickel plating. Commercial performance is successful in barrel and tank plating baths.

Acknowledgments

The authors acknowledge with appreciation the permission of the City Auto Stamping Company, the General Electric Company, the Standard Steel Spring Division of the Rockwell Spring and Axle Company, and Battelle Memorial Institute to publish the data given in this paper.

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DISCUSSION

Mr. A. Adams (Armalite Company, Ltd., Toronto, Ontario): You mentioned a new speculum plating solution but were unable to explain due to lack of time. Is this similar to the British process where a separate anode connection is required for the tin and copper anodes, giving a double positive arrangement, or does your solution use an alloy copper-tin single anode arrangement?

Mr. Safranek: The new process for electrodepositing copper-tin alloys, including both bronze and speculum alloys, utilizes cast alloy anodes that replenish the copper and tin content in the same ratio and at the same rate that they are deposited at the cathode. There are many considerable differences between the new improved process and the old copper-cyanide-sodium stannate bath, which you refer to as the British process. Some of the differences in the operating characteristics and bath formulations are given in the manuscript prepared for publication. It should be pointed out that the so-called British process is the one covered by U. S Patents Nos. 2,511,395 and 2,397,522 and Canadian Patent No. 468,932.

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STRESS IN CHROMIUM DEPOSITS*

J. E. STARECK,† E. J. SEYB,† AND A. C. TULUMELLO†

Introduction

The significance of stress in the performance of electrodeposited coatings has been realized only in recent years after improved techniques for the measurement of stress had been developed. Stress is believed to play an important role in the corrosion properties of decorative deposits and in the performance of parts in engineering applications. This study of the stress exhibited by chromium deposits from a number of solutions at several plating conditions of current density and temperature was designed to include many known types of chromium deposits. The data were obtained as part of a larger study on the significance of stress on the fatigue properties of chromium plated steel. The important relationship of stress in chromium and the fatigue strength of chromium plated steel will be the subject of a later paper based on the results of this study.

Stress in chromium electrodeposits is covered only in an introductory way in the literature. The first clear presentation of stress in chromium electrodeposits was made by Brenner and Senderoff[1] who obtained a continuous stress vs thickness curve that showed stress in chromium is not constant but changes with thickness. Hume-Rothery and Wylie[2] had previously given stress measurements for electrodeposited chromium, but the deposition was carried out at 11 asi, making their results difficult to compare with more common deposits since they do not correlate with the usual known physical properties of electrodeposited chromium. Since the spiral contractometer[3] had been successfully used to measure stress in chromium deposits, the first part of the stress measurements were made with this instrument. Later in the investigation, the desirability of measuring stress of chromium after baking became evident and the rigid flat-strip method[3] was adopted because a plated strip could be baked and its curvature remeasured easily by this method.

Description of the Spiral Contractometer

The spiral contractometer is a commercially available instrument (Fig. 1) in which a thin metal strip (approximately 0.010 to 0.015 inch by 0.75 inch) is wound in the form of a helix with one end firmly attached to the instrument while the other end is allowed to turn an indicator dial. The inside of the helix is stopped-off so that only the outside is plated, thus stress in a deposit is transferred to one side of the strip resulting in rotation of the free end of the helix as indicated by a change in dial reading.

The mathematical considerations with this instrument have been discussed thoroughly[1] and will not be repeated here. In these studies a helix was calibrated before each trial by measuring the dial deflection in degrees produced by a one-ounce calibrating weight. The calculations were as follows:

$$S = \frac{d}{8\,D\,p\,t\,t'}$$

where:

- S = Stress in psi
- d = Degrees deflection due to stress in a deposit
- D = Degrees deflection with 1 ounce calibrating weight
- p = Pitch of helix in inches
- t = Base metal thickness in inches
- t' = Plate thickness in inches

The helices were prepared from 18:8 stainless steel with a nominal thickness of 0.012 inch and a hardness

Fig. 1. Spiral contractometer: left, unassembled helix; right, assembled helix and dial indicator

*Presented at the Forty-First Annual Convention of the American Electroplaters' Society, 13 July 1954.

†Director of Research, Research Chemist, and Research Chemist, respectfully, United Chromium, Incorporated, Detroit, Michigan.

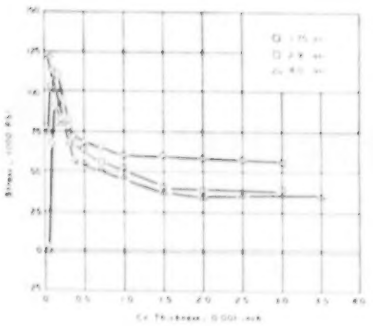

Fig. 2. Stress vs thickness, spiral contractometer method, ordinary chromium bath, 150° F

of approximately 200 DPH (RB 90) and, unless otherwise stated, chromium was deposited directly on steel. This corresponds to the usual procedure of plating chromium directly on steel in engineering applications.

Prior to plating, the helices were cleaned anodically for 30 seconds in an alkaline electrolytic cleaner, water rinsed, dipped in 2 per cent H_2SO_4, and water rinsed. Each helix was allowed to sit in a water bath at the same temperature as the plating solution for five minutes and then in the plating solution for two minutes so that temperature equilibrium would be established before a zero reading was taken. The helix was then plated at the specified conditions.

Effect of Cathodic Gassing on a Stainless Steel Spiral

A preliminary test was run to determine the role of hydrogen penetration in the base metal on the stress characteristics of an unplated stainless steel helix. This test was necessary since chromium plating releases a large volume of hydrogen and its effect on the steel base metal might be of importance. Hydrogen was plated cathodically from a 10 per cent sulfuric acid solution at 100° F and 0.5 asi for 2 hours. A small deflection in the negative direction (expansion of outer steel surface) was observed indicating some stress due to hydrogen penetration. Allowing the spiral to stand in the bath without current permitted the helix to go back slowly toward its original position. Anodic treatment at the same current density in the sulfuric acid solution brought the deflection back to zero rapidly but severely etched the steel helix. The data indicate that hydrogen released at the cathode will give a stainless steel spiral a small negative deflection which is relieved only slowly on standing. These observations are in agreement with the findings of Vuilleumier[4] and Phillips and Clifton[3] as to the effect of hydrogen penetration on the stress in a base metal.

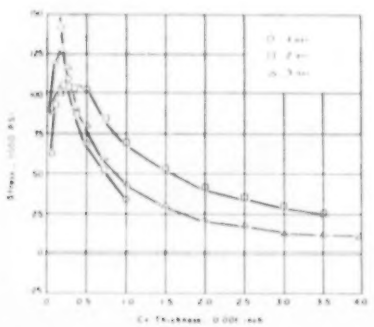

Fig. 3. Stress vs thickness, spiral contractometer method, ordinary chromium bath, 130° F

Stress in Ordinary Chromium Deposits

Since the sulfate catalyzed bath has been studied more extensively than other chromium plating baths, stress data with the spiral contractometer was obtained first from this bath at several commonly encountered plating conditions. For this study a stock solution with 250 g/l of CrO_3 and 2.5 g/l of SO_4 (100 to 1 ratio) was prepared.

At 150° F stress vs plate thickness curves were made at current densities of 1.75, 2.9, and 4.0 asi, which represents low, medium, and high current densities at this temperature. The data are plotted in Fig. 2. This type of curve for stress vs thickness is of general interest. The tensile stress rises rapidly for thin deposits of chromium until a maximum is reached and then drops gradually, leveling off near 2 mils thickness. This type of curve is commonly encountered in one form or another in chromium deposits, that is, high stress for thin deposits with decreasing stress as the deposit thickness is increased.

An examination of the individual curves shows that at the lower current density of 1.75 asi, the stress in the deposit reaches a maximum of 85,000 psi and then decreases with increasing thickness to 55,000 psi. Although the beginning stress is lower than for the higher current density deposits, it possesses higher stress at thicknesses greater than 0.5 mil. The stress in the 2.9 asi deposit increased more rapidly with thickness and reached a higher maximum value of 110,000 psi but at greater thicknesses leveled off to a lower stress value than the 1.75 asi deposit. In the highest current density deposit used at this temperature (4.0 asi), the first readings shown in the graph already exhibit the downward trend and the final stress attained at greater thickness is the lowest of the three current densities.

The same chromium plating solution was also studied at 130° F with low, intermediate, and high current densities for this temperature, i.e., 1, 2, and 3 asi. Here, in Fig. 3, the stress values have shifted to a somewhat lower value than those obtained at 150° F. The 1 and 3 asi deposits gave lower final stress values than did the intermediate current density deposit. The trend mentioned previously indicating that the deposits with the highest initial stress give the lowest final stress is again illustrated.

Figure 4 gives the stress vs thickness curves for deposits from the same ordinary solution plated at 110° F. The decrease of 20 degrees in temperature gives chromium deposits with decidedly lower final stress values. Here the stress values are high initially, but fall off even more rapidly than for deposits at higher temperatures. At about 3.0 mils thickness the stress actually crosses the zero axis and becomes negative or compressive.

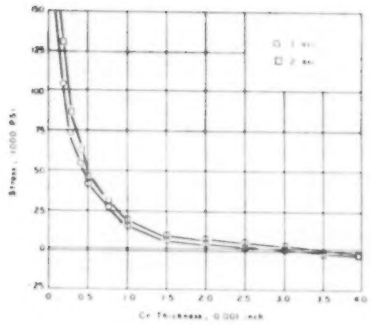

Fig. 4. Stress vs thickness, spiral contractometer method, ordinary chromium bath, 110° F

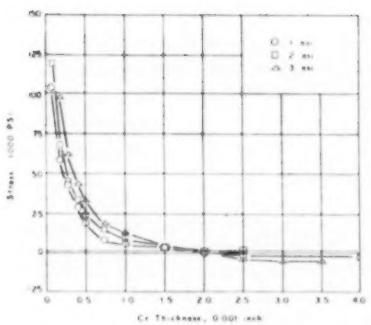

Fig. 5. Stress vs thickness, spiral contractometer method, CR-110 bath, 130° F

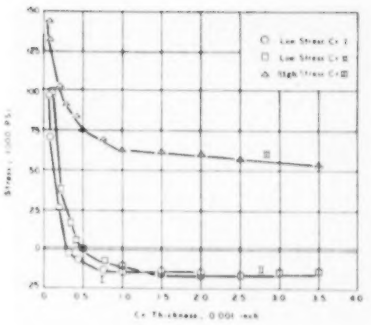

Fig. 6. Stress vs thickness, spiral contractometer method, high and low stress chromium

Stress in CR-110 Deposits

Another interesting set of stress curves is given in Fig. 5. Here the proprietary CR-110 bath[5] with 225 g/l of CrO_3 at 130° F produces a deposit with stress vs thickness curves which begin at higher stress values and drop more rapidly than any deposit previously shown. The final stress values are lower for this deposit at 130° F than were obtained with the ordinary solution at the much lower temperature of 110° F and very much lower than those obtained at 130° F with that solution. Here the stress becomes negative at approximately 2 mils thickness showing compressive stress in the chromium. A final stress of approximately −1000 to −4000 psi is attained. In the course of the investigation this deposit was the first one to show compressive stress and, therefore, several runs were made to make certain compressive stress was being obtained.

Figure 6 shows the very wide stress range which can be obtained at will with the proprietary CR-110 bath at different concentrations and plating conditions. A high tensile stress of 60,000 psi at 2 mils thickness for the 315 g/l bath at 140° F and 3 asi (Curve III) and a compressive stress of −17,000 psi for the 180 g/l bath at 110° F and 1 asi (Curve II) and the 225 g/l bath at 90° F and 0.25 asi (Curve I) were obtained. The curves represent both the highest and the lowest stress values obtained in this study.

Correlation of Crack-Pattern and Stress

A microscopic examination of an unetched chromium surface shows a great difference in the number of crack-lines possessed by the different chromium deposits. A semi-quantitative method for obtaining the number of cracks in a deposit is to count the average number of crack-lines in the unetched chromium surface that cross an arbitrary straight line one inch long. By counting crack-lines in this way a method of comparing crack-patterns between deposits is available.

Thus, it is found that the deposit for Curve II in Fig. 6 possesses 3,500 crack-lines per linear inch and possesses compressive stress at thicknesses greater than 0.5 mil. The deposit for Curve III with its high tensile stress possesses only 22 crack-lines per inch. This example illustrates that the fewer the number of crack-lines a deposit possesses, the higher its measured tensile stress. Conversely, the more numerous the crack-lines, the lower the stress for thicker deposits.

Such a correlation between stress and number of crack-lines is further demonstrated in Table I. In the previous curves, stress began to level off at near 2 mils thickness and hence the stress at this thickness was chosen as being characteristic for a deposit. It is seen in Table I that the stress follows the general rule that the more numerous the crack-lines the lower the measured stress. The significant connection between stress and crack-pattern makes it possible to predict the

TABLE I. CORRELATION BETWEEN CRACKS AND STRESS

Bath	Plating Conditions	Stress, 1000 psi (2 mil thickness)	Cracks (per inch)
CR-110, 180 g/l	110° F, 1 asi	−17	3,500
CR-110, 225 g/l	130° F, 2 asi	− 3	1,300
Ordinary chromium	110° F, 1 asi	3	1,200
Ordinary chromium	130° F, 2 asi	40	400
Ordinary chromium	150° F, 2.9 asi	47	50
CR-110, 315 g/l	140° F, 3 asi	60	22

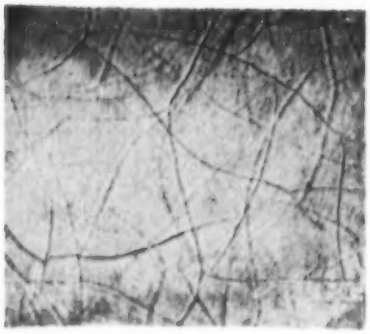

Fig. 7. Unetched chromium surface showing open and filled-in cracks. 2000X

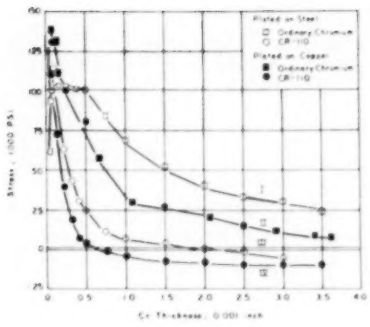

Fig. 9. Stress vs thickness, spiral contractometer method, chromium deposited on copper and steel

approximate stress in many deposits since the crack-pattern obtained from a number of solutions at many plating conditions have been reported.[6]

The shape of the stress vs thickness curves with a change from high stress for thin plates to low stress for thicker plates also indicates the influence of the cracking process on stress relief. Thus a general picture can be seen in which tensile strength increases with increasing thickness until the tensile strength of chromium is exceeded and then cracking occurs with its relief of tensile stress.

Stress relief through cracking is a satisfactory explanation for a decrease in the tensile stress of a deposit, but mere stress relief would permit stress to decrease only to zero and would not explain compressive or negative stresses encountered with deposits possessing a finer crack-pattern. Here an additional explanation is necessary to show how a deposit that is shown initially to possess high tensile stress can later show compressive stress. The compressive stress is shown to accompany deposits that possess the most numerous crack-lines and the highest initial stress. Hence it is reasonable to assume that the negative stress is connected with the appearance of cracks. Under a microscope most of these crack-lines are shown to be healed-over cracks rather than open cracks as is shown in Fig. 7. In this connection it has been shown[7] that chromium plating baths possess exceptionally good micro-throwing power and are able to deposit chromium into small cracks. Thus it is seen that when a crack opens up during plating, deposition takes place in that crack and as deposition proceeds successive layers of filled-in cracks are formed. These filled-in cracks are encountered in chromium deposits of any appreciable thickness. Figure 8 shows schematically a postulated mechanism for the formation of compressive stress by the deposition of chromium in cracks in which the crystal growth builds inward from the two edges of a crack. When the chromium meets at the center of the crack the crystals continue to grow, exerting an expansive force on the two edges. Thus the stress behavior of chromium deposits is not only concerned with tensile stress relief through cracking, but also with the formation of expansive forces by crystal growth of chromium as it is deposited in cracks. When these filled-in cracks are numerous enough, the expansive forces are greater than the contractile forces and a deposit possessing an average compressive stress is obtained.

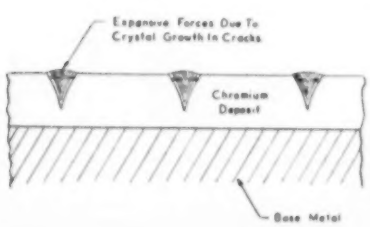

Fig. 8. Schematic diagram showing the postulated mechanism for the introduction of expansive forces

Stress Comparison for Chromium Deposited on Copper and Steel

The stress data given in this report are substantially higher for the deposit from the ordinary sulfate bath at 130° F than those obtained by Brenner and Senderoff[1] in spite of the fact that the spiral contractometer was used as the measuring instrument in both cases. The Brenner and Senderoff data apparently were measured with chromium deposited directly on copper helices, while the data here is for chromium plated directly on stainless steel. In order to check this possible source of difference, copper was deposited on the stainless steel and then stress in chromium measured when deposited on the copper plated helix.

Copper from a pyrophosphate copper bath at 130° F and 0.33 asi was plated to 1.0 mil thickness on a stainless steel helix. After calibration of the copper plated helix, chromium was deposited on the copper plate and the stress in chromium measured. The ordinary chromium plating bath of 250 g/l CrO_3 with 2.5 g/l of SO_4 at 130° F and 2 asi gave the stress shown as Curve II in Fig. 9 when deposited on the copper as compared to Curve I when deposited directly on stainless steel. It is seen that lower values of stress are obtained when the chromium is deposited on the copper rather than on the steel. Curve IV as compared to Curve III (Fig. 9) similarly shows the lower stress obtained with the CR-110 bath at 225 g/l of CrO_3, 130° F, and 2 asi when plated directly on copper as compared to steel.

The magnitude of the difference in stress values is significant for both chromium deposits. The shift in the curve indicates that the formation of a crack pattern, which was shown in Table I to be closely related to stress, is occurring more easily with the soft copper base metal than in the case where chromium has the much stronger backing of stainless steel.

Instantaneous Stress in Chromium Deposits

An examination of a stress curve for a deposit possessing compressive stress (Fig. 5) reveals a high internal stress as chromium begins to deposit and then as thickness increases a rapid decrease in stress until the stress curve goes negative. The initial stress is higher for this deposit than it is for a deposit with fewer crack-lines, but cracking in the deposit begins almost as soon as readings can be taken, as shown by the steepness of the stress vs thickness curve. The exceptionally rapid change from high to low stress for the highly cracked deposit would indicate that the instantaneous stress might actually be negative much sooner than is shown by the total stress curve. This would be true if a high initial tensile stress is present and as chromium thickness is increased the tensile strength of the deposit is exceeded and microscopic cracks appear over the entire area at nearly the same time so that the stress quickly becomes compressive as new chromium is deposited in the cracks. Such a rapid change from high tensile stress to small compressive stress would be shown in the average stress curve only by a slow change in which the small compressive stress equalizes and finally exceeds the initial high tensile stress.

A formula for calculating instantaneous stress in a deposit was derived by Brenner and Senderoff[1] for cases in which the stress is changing rapidly with thickness. Without going into the details of the derivation, the following final formula was given:

$$S_i = S_a - m$$

where the symbols have the significance shown in Fig. 10.

An analysis of several stress curves for instantaneous stress in the manner described above gives reasonable values for limiting stress. But for thin deposits where the slope of the tangent is very steep and difficult to determine accurately, it is hard to tell when the instantaneous stress actually becomes negative.

The data plotted in Fig. 11 show the results of an experiment to determine when the instantaneous stress became negative. The bath, CR-110, 225 g/l, at 130° F and 2 asi was used, and the spiral contractometer was taken from the bath and recalibrated at the end of 10, 30, and 90 minutes of plating. After each calibration, the plated spiral contractometer was again placed in the plating solution and plated until the next calibration.

The data were calculated in two ways. One method gives the average stress as related to total thickness, while the other method gives the stress as related to

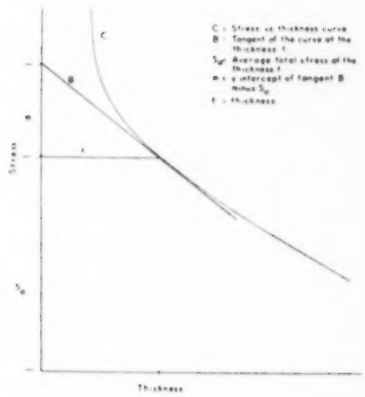

Fig. 10. Diagram for calculation of instantaneous stress, Si

the thickness of the layer of chromium after each calibration. The chromium deposit was bright and showed excellent adherence between plates with no visible evidence of peeling or double plate. Curve II in Fig. 11 for the deposit without plating interruptions is given for comparison with the total average stress curve to show that the usual curve was obtained. The total stress, Curve I, follows Curve II of the control deposit quite closely, showing that the mechanical handling and the disrupted current during calibration did not greatly change the stress compared to the continuous deposit. The layer stress values, Curve III, show that after 10 minutes of plating (0.2 mil thickness) a low stress value of 9,000 psi was obtained, which rapidly dropped to a negative value. The data show that in this CR-110 deposit the stress is already negative after 12 minutes of plating (0.24 mil) although the total stress curve does not become negative until 1.5 to 2 mils thickness is attained. The data show that with deposits of this type the first few minutes of plating are of utmost significance as far as tensile stress is concerned and that the actual layer or instantaneous stress is negative by the time 0.1 to 0.2 mils are deposited, with all chromium plated afterward at greater thicknesses being compressively stressed.

Stress in Alternate Layers of Low and High Stress Chromium

A graphic presentation of the effect of different types of chromium on stress when alternate layers of high and low stress chromium are plated on each other is

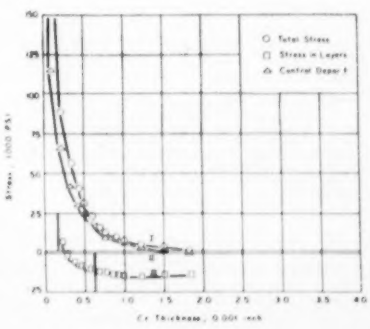

Fig. 11. Stress vs thickness, spiral contractometer method, instantaneous stress in chromium

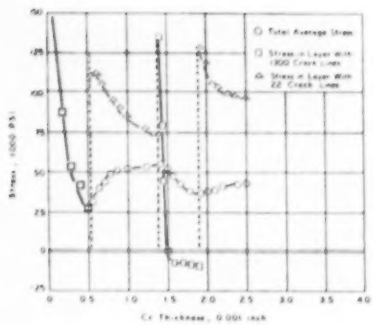

Fig. 12. Stress vs thickness, spiral contractometer method, alternate layers of high and low stress chromium

given in Fig. 12. Here a 0.5 mil deposit with 1,300 crack-lines per linear inch (CR-110, 225 g/l, 130° F, 2 asi) was plated on a steel helix. The typical rapid drop from high to low stress was obtained for this deposit. The helix was then taken from the bath, recalibrated, and 0.9 mil of chromium possessing only 22 crack-lines per inch from the CR-110 315 g/l bath at 140° F and 3 asi was deposited on top of the fine crack-pattern chromium and so on. The total stress and the stress in the different layers were both plotted. As the deposit thickness increased, the average stress dropped when low stress chromium was deposited and increased when high stress chromium was deposited.

Stress in individual deposit layers also shows some interesting features. The first 0.5 mil is low stress chromium and as such shows the usual high initial stress and as the crack pattern is established gives a rapid decrease in stress. The next layer is a high stress type of chromium which starts at a high stress value and gradually falls to about 60,000 psi, which was the value obtained for the deposit alone. The stress behavior of the next layer of low stress chromium beginning at 1.5 mils total thickness is very interesting because, although the first stress value for the layer is 133,000 psi, the stress falls to a compressive or negative value by the time the layer reaches 0.1 mils thickness. This exceptionally rapid drop in stress can be attributed to the ease and quickness with which the low stress chromium can assume its natural fine crack pattern when plated on the high stress chromium. The second layer of high stress chromium, beginning at 1.9 mil total thickness, again starts at a high stress value and drops gradually with thickness giving its usual type of curve.

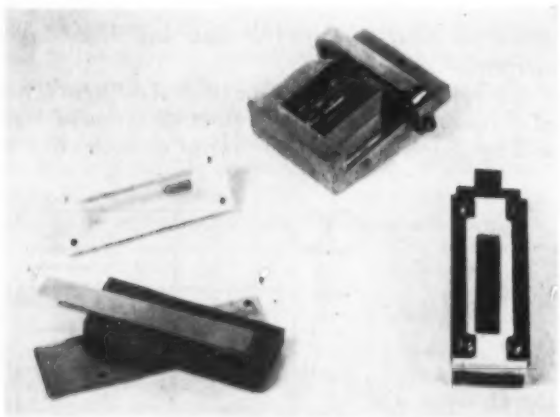

Fig. 13. Rigid flat-strip method: lower left, unassembled plating fixture; lower right, assembled plating fixture; top, instrument to measure height of curvature

Description of Rigid Flat-Strip Method

The stress data presented thus far give a picture for stress in chromium deposits over the crack-pattern range from those possessing only a few crack-lines (high stress) to those possessing a large number of crack-lines (low stress). However, considerable interest is directed to applications where parts are operated above room temperature or where baking of the plated part is required for relief from hydrogen embrittlement. The spiral contractometer is not readily adapted to the measurement of stress after baking since difficulty arises in taking a helix from its indicating apparatus for baking and then returning the helix for remeasurement. In order to measure stress after baking, the rigid flat-strip method[3] was adopted, since the method readily permits measurement of a piece and then remeasurement after removal for heat treatment. The method is fully described and the mathematical relationships are derived in the literature.[3,8,9] Only the basic principles are given here.

The plating fixture, unassembled and assembled, is shown in Fig. 13. This fixture holds a strip rigid during plating, serves to stop-off the back and ends of the strip, and acts as a shield to provide even plate distribution. After plating, the strips were taken from the plating fixture, allowed to bend, and the radius of curvature measured by determining the height of curvature from a chord, in the measuring device also shown in Fig. 13. Here the plated strip is firmly held between the two jaws which establish the length of the chord, and the height of curvature is determined with an inside micrometer. Measurements were made at the same position on a strip before and after plating and, if the strip was baked, also after baking. A strip was held straight by two pieces of asbestos during baking and while cooling to room temperature, and then the strip was allowed to bend to its equilibrium position. All measurements for radius of curvature were made at room temperature.

The test strip was 0.012 inch shim stock with a hardness of approximately 200 DPH (RB 90), the same hardness as the stainless steel helices used in the spiral contractometer. The plating area was 9/16 by 2 5/8 inches and the length of the measured chord, L, was 1.53 inches.

The mathematical formula is given as follows:

$$S = \frac{4\,E\,(t + t')^3\,d}{3\,L^2\,t\,t'}$$

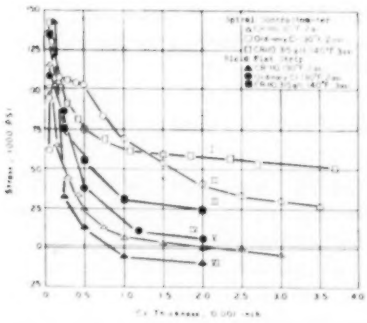

Fig. 14. Stress vs thickness, comparison of rigid flat-strip and spiral contractometer methods

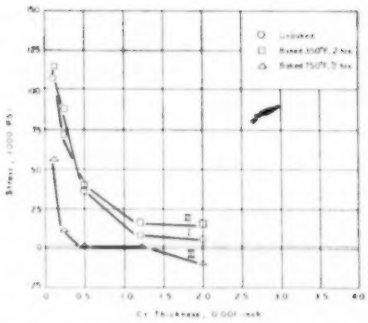

Fig. 15. Stress vs thickness, rigid flat-strip method, ordinary chromium

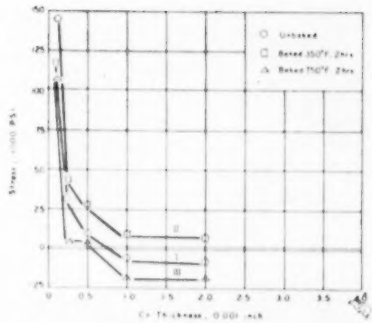

Fig. 16. Stress vs thickness, rigid flat-strip method, low stress chromium

where:

S = Stress in the deposit in psi
E = Modulus of elasticity in test strip, 29 x 10^6 psi
t = Thickness of strip in inches
t′ = Thickness of deposit in inches
d = Measured height of curvature in inches
L = Length of chord

Stress in Chromium Deposits After Baking

Three deposits representing the full range from high to low stress values previously measured with the spiral contractometer were again tested for stress by the rigid flat-strip method. A comparison between data for the same deposits taken by the spiral contractometer and rigid flat-strip methods are shown in Fig. 14. Curves I and III represent the results obtained with high stress chromium (22 crack-lines per inch, CR-110 315 g/l, 140° F, 3 asi). Curve I is the curve, shown previously in Fig. 6, taken with the spiral contractometer, while Curve III was measured by the rigid flat-strip method. At a thickness of two mils the difference in stress as indicated by the two methods is quite large, varying from approximately 24,000 psi to 61,000 psi. Curves II and IV represent the stress measurement for ordinary chromium deposits at 130° F and 2 asi using the two methods. Again the strip held rigid during plating (Curve IV) shows much lower stress than the strip allowed to bend during plating as represented in Curve II. The same trend is exhibited by the Curves V and VI, which are for the low stress deposit from CR-110, 225 g/l, 130° F, 2 asi.

This difference in magnitude of stress shown by the two methods of measurement is again attributed to the peculiar situation encountered with chromium in which cracks are formed and healed over during plating. The moving strip, used with the spiral contractometer, permits some external stress relief of the chromium by bending during plating which results in the formation of fewer cracks. Hence the situation permitting mechanical stress relief, actually results in giving a higher average stress in the deposit. In every case the strips held rigid during plating gave stresses which dropped in magnitude more rapidly with thickness and leveled off at lower stress values than the same deposits measured with the nonrigid spiral contractometer.

It is interesting to note that with the rigid strip method, as with the spiral contractometer, high stress is obtained at 0.1 mil and drops rapidly as thickness is increased. Thus the same general shape of curve is obtained by both methods, but the stress with the rigid strip drops to the lower value. It is also observed that when testing by the rigid strip method no maximum is encountered with the thinnest deposits tested but rather the crack formation is already taking place at the first reading, and only a rapid drop in stress is encountered.

Figure 15 gives the stress vs thickness curves for the intermediate stress deposit (400 crack-lines per inch) from ordinary chromium plating solution described previously at 130° F and 2 asi before and after baking at 350° F and 750° F. Tests were made at thicknesses of 0.1, 0.5, 1.2, and 2.0 mils. Curve I gives the stress obtained before baking, Curve II gives the stress after baking at 350° F for 2 hours, and Curve III after baking at 750° F for 2 hours. After baking at 350° F and cooling to room temperature, the deposit possesses a higher tensile stress than the unbaked deposit. At 2 mils thickness the stress has increased from +8,000 psi to +16,000 psi, doubling the stress exhibited by the deposit before baking. This change in stress in the tensile direction on baking is in accord with measurements on the density of electrolytic chromium, which have shown shrinkage on baking[10] due to loss of hydrogen from the deposits. After heating at 750° F and cooling to room temperature, the stress has decreased at all thicknesses tested, with the 2 mil deposit showing a compressive value of −9,000 psi. The suggested explanation for the negative stress is that tensile stress between the chromium deposit and steel has become so high, due to shrinkage of chromium and to the higher thermal coefficient of expansion for steel than for chromium, that permanent plastic deformation has occurred at 750° F in either the steel or the chromium or both. On cooling this deformation would be exhibited as negative or compressive stress in the chromium.

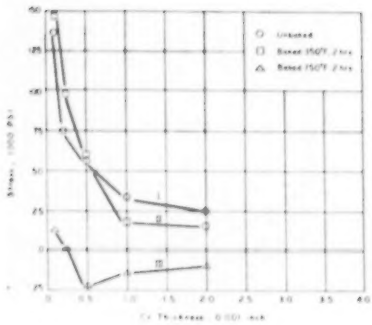

Fig. 17. Stress vs thickness, rigid flat-strip method, high stress chromium

Figure 16 gives stress results before and after baking for the 225 g/l CR-110 deposit at 130° F and 2 asi (low stress chromium, 1300 crack-lines per inch). For the unbaked deposit (Curve I) the stress begins quite high, but drops rapidly and is −6,000 psi at 1.0 mil thickness and −9,000 psi at 2 mils. After baking at 350° F for 2 hours and cooling to room temperature, the stress has increased at +11,000 psi at 1 mil and 12,000 psi at 2 mils. After baking at 750° F for 2 hours, the stress has decreased at all the thicknesses tested. At 2 mils the stress dropped to −15,000 psi.

Figure 17 gives stress curves for the highly stressed chromium deposit possessing approximately 22 crack-lines per inch. The bath used for this type of deposit was the CR-110, 315 g/l bath operated at 140° F and 3 asi. Curve I is for the unbaked deposit, Curve II after baking at 350° F for 2 hours, and Curve III after baking at 750° F for 2 hours. Baking at 350° F increased the resulting stress compared to the unbaked deposits for the thin deposits of 0.1, 0.25, and 0.5 mil. For thicknesses of 1.0 and 2.0 mils, however, the 350° F bake produced lower stresses. This is the only deposit of the three tested which gave lower rather than higher stress when baked at 350° F. It is interesting to note that the deposit showing the highest unbaked stress gave the only indication of stress relief on baking at 350° F. After baking at 750° F a decided lowering in stress was obtained at all thicknesses with this deposit. The amount of lowering in stress between the 350° F bake and the 750° F bake is by far the largest

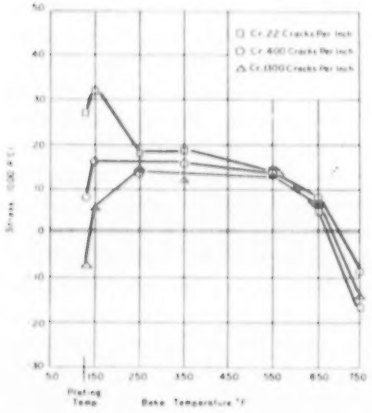

Fig. 18. Stress vs bake temperature; 2 mils chromium thickness

of the three types of deposits. Compressive stress values of −17,000 psi were obtained for the 1.0 and 2.0 mil deposits.

Stress in Chromium After Baking at Different Temperatures

Significant data by the rigid flat-strip method is given in Fig. 18 for stress in chromium after baking. The stress vs baking temperature curve was studied by baking a series of deposits of 2 mils thickness for 2 hours at a number of baking temperatures. The strips were held straight during the baking treatment and during cooling, were allowed to bend at room temperature, and then measured at room temperature. Thus, as before, the data does not represent the stress at the baking temperature but rather the stress at room temperature after baking.

The three deposits investigated previously representing high, medium, and low stress chromium were again studied. These were the high stress chromium with 22 crack-lines per inch from the CR-110 bath at 315 g/l and 140° F and 2 asi, the medium stress chromium with 400 crack-lines per inch from the ordinary plating bath with 250 g/l of CrO_3 and 2.5 g/l SO_4 at 130° F and 2 asi, and the low stress chromium with 1300 crack-lines per inch from the CR-110 bath, 225 g/l bath at 130° F and 2 asi.

An examination of Fig. 18 shows that considerable increase in stress is observed with all three deposits after baking at 150° F, just a few degrees higher than the plating temperature. Since electrodeposited chromium has been shown to undergo an increase in density on heating,[10] this stress increase may be attributed to shrinkage of the deposit. Contraction of chromium is usually attributed to the loss of hydrogen from the deposit on heating and thus the increase in stress of electrolytic chromium on baking can be also connected to the loss of hydrogen.

When the baking temperature is increased to 250° F, the stress for the high stress chromium (22 crack-lines per inch) has dropped, indicating that in this deposit the tensile stress due to shrinkage has exceeded the tensile strength of either the chromium or the steel and some stress relief by cracking or deformation has occurred. The intermediate stress chromium (ordinary chromium, 400 crack-lines per inch) has changed its stress very little, while the low stress chromium (1300 crack-lines per inch) unlike the higher stress chromium shows a considerable stress increase in the baking temperature range from 150° F to 250° F. This indicates that with this deposit hydrogen is still being expelled above 150° F.

Although the three "as plated" deposits possessed very different stresses ranging from −8,000 psi to +27,000 psi, yet after baking at 250° F, the stresses have come much closer together with a range from 13,000 to 19,000 psi. The high stress chromium has increased its stress so high that stress relief has been obtained and is actually lower than the initial stress, while the

low stress chromium has increased its stress without yet attaining stress relief.

From 350° F to 550° F little further change in stress is observed with the three deposits. No indication of further increase in stress due to contraction is observed after baking above 250° F, indicating that the initial reaction causing this change was balanced by a competing reaction or was complete at 250° F.

Above 550° F, a definite decrease in stress is observed for all three deposits. The decrease is definite at 650° F and even more rapid up to 750° F. The high stress deposit shows the first tendency for a stress decrease at the higher baking temperatures and actually becomes the deposit with the lowest stress after baking at 650° F and 750° F. This change in relative position might be due to greater ductility compared to the other two deposits. For all three deposits, the stress after baking at 750° F is lower than the "as plated" stress and is negative or compressive. If the stress were simply zero after this high temperature bake, it could be attributed to cracking of the deposit. A negative stress, however, requires an additional explanation.

The negative stress in a chromium deposit after baking can be explained if the stress becomes high enough to exceed the tensile strength of either the chromium or the steel. The stress changes at 150° F to 250° F can readily be attributed to the loss of hydrogen from the deposit at those temperatures. Above 550° F, however, the change in stress is more probably due to stress between chromium and steel being increased due to differences in coefficients of thermal expansion of the two metals to such a degree that tensile strengths are exceeded, permanent plastic deformation occurs, and on cooling to room temperature this deformation is reflected in negative or compressive stress exhibited by the chromium.

Careful evaluation of the stress vs baking curve introduces the question of whether the same shape of curve would be obtained with different base metals or with steel with higher hardness. Since it is suggested that the shape of the curve after baking at temperatures up to 350° F is connected with the shrinkage of a deposit with its loss of hydrogen, a base metal which changed the rate of escape of hydrogen could also change the shape of the stress vs baking temperature curves. Similarly above 500° F, the shape of the curve may be dependent on whether a base metal gives a little under the high stress induced by uneven thermal expansions at this temperature, and thus steels with different tensile strengths could give different stress vs baking temperature curves at temperatures above 500° F. Since interest is centered in chromium plated high strength steels for engineering applications, it would be desirable to use hardened steel strip for stress measurements after baking. Technical difficulties in hardening a thin steel strip are encountered because of severe warping in the heat treating process. Hardened steel strips thin enough to give sufficient curvature for stress measurements when plated and yet straight enough before plating to provide reliable measurements have not yet been obtained.

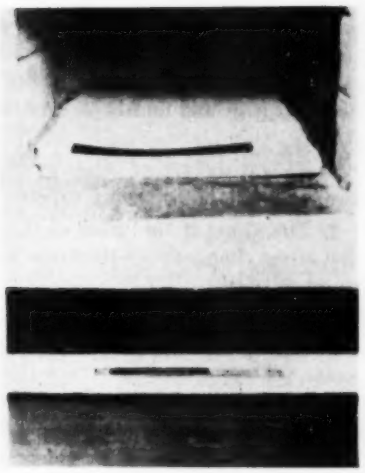

Fig. 19. Uneven thermal expansion in chromium plated steel: top, strip in oven at 750° F; bottom, same strip at room temperature

The problem encountered with chromium plated steel when the article is baked and then tested at room temperature is quite a different situation than when a part actually operates at well above room temperature. This important relationship was emphasized in the baking of chromium plated flat strip. The thermal expansion of steel is much greater than that for chromium. When the strip plated on one side was allowed to bend while in the oven at 750° F a pronounced tensile stress with respect to chromium was observed. If this same strip was allowed to cool to room temperature the chromium was shown to possess a negative or compressive stress. This situation is illustrated in Fig. 19. The upper strip was photographed while in an oven at 750° F. The chromium and steel act as a bimetallic element in which the ends are bending upward because of the difference in coefficients of expansion of 4×10^{-6} per ° F for chromium and 8×10^{-6} per ° F for low carbon steel.[11] After cooling to room temperature the same chromium plated strip bends in the opposite direction with the ends turning downward slightly, as shown by the lower strip in Fig. 19.

Factors active in determining the stress exhibited by a deposit after baking, as shown by the stress vs baking temperature curve, are:

1. Stress in the "as-plated" deposits;
2. Contraction of a particular deposit on baking;
3. Coefficient of thermal expansion of the deposit;
4. Coefficient of thermal expansion of the basis metal;
5. Permanent deformation of the chromium;
6. Permanent deformation of the base metal.

Discussion

The stress curves given in this paper show that stress in chromium involves a complex mechanism. If a deposit possesses tensile stress high enough to rupture the plate, then the final average stress drops to a low value and with certain deposits is actually compressive; if a deposit inherently possesses a lower stress

not high enough to rupture the deposit, then the final stress remains high. Thus high inherent stress in a deposit will produce a larger number of cracks which in turn result in low tensile or even compressive average stress.

A general picture of stress in chromium deposits is formed from the following experimental observations:

1. The shape of the stress vs thickness curves shows that stress changes with thickness until a crack-pattern is established.

2. The stress exhibited by a deposit is shown to be numerically correlated with the crack-pattern in a deposit. Thus numerous crack-lines result in lower stress; and conversely the fewer the number of crack-lines, the higher the stress exhibited by a deposit.

3. Negatively or compressively stressed chromium deposits, not previously reported in the literature, were obtained with fine crack-pattern chromium. Since more than stress relief by cracking is involved, it is postulated that redeposition of chromium in open microscopic cracks introduce expansive forces, possibly by crystal growth, which are high enough for the deposit to exhibit compressive stress.

4. The instantaneous stress in deposits showing compressive stress at 2 mils thickness are shown experimentally to be negative as soon as the crack-pattern is established in the first few minutes of plating.

5. Stress in chromium deposited on copper is lower than when plated on steel. This experimental result is attributed to the weaker backing provided by copper which permits the chromium crack-pattern to become established more rapidly resulting in lower stress.

6. Stress in chromium deposits is lower when measured by the rigid flat-strip method than by the spiral contractometer method. This experimental result is attributed to the relief of stress in a deposit by bending during plating in the spiral contractometer method resulting in the formation of fewer cracks and hence a higher measured stress. The strip held rigid during plating permitted stress relief in a deposit only by cracking which with redeposition in the crack-lines resulted in a lower stress in a deposit.

7. Baking up to 350° F increases the stress in a deposit, which is attributed to shrinkage of electrolytic chromium due to loss of hydrogen. After baking at higher temperatures, the stress decreases and with the steel base metal used in these experiments crossed the zero stress axis at approximately 700° F.

Acknowledgement

The data reported here are a part of a larger study on the fatigue properties of chromium plated steel conducted by United Chromium Research Laboratories for the Protective Coatings Division, Wright Air Development Center, Wright Patterson Air Force Base, Ohio. The authors wish to thank the above organization for permission to publish these data.

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DISCUSSION

Mr. A. W. Logozzo (Nutmeg Chrome Corporation, West Hartford, Conn.): In the observations you made of stress relieving temperatures, particularly at 750° F, was any attention paid to the decrease in hardness of the chromium deposit itself? If so, would you care to comment on what it was?

Dr. Seyb: Hardness measurements after baking were not made in this study. Published data [Hosdowich, *Proc. Am. Electroplaters' Soc.* **36**, 103 (1949), and Brenner, Burkhead, and Jennings, *ibid*, **34**, 32–73 (1947)] would indicate that after annealing at 700° to 750° F very little change, if any, would be found.

Mr. Logozzo: In your word of caution on the 750° F temperature as far as a particular type steel was concerned, did you mean that this should not be used as a standard means of stress relieving because of the danger at 750° F of softening many types of steel below the usable hardness values set by the function of that particular part?

Dr. Seyb: No, we were considering the stress in chromium deposits. The data indicate that different stress values may be obtained with other base metals or with harder steels. The word of caution was intended to emphasize the comparative stress values for different deposits rather than their use as absolute values in unrelated situations.

Mr. Logozzo: I would like to insert a word of caution. One must consider the metallurgical factors at all times and these should be thoroughly discussed with whoever is going to use the part, because 750° F has been known to soften the steel to a point where one can get into trouble. I emphasize this because the value of relieving the stress in the chromium is recognized.

On one of your diagrams you showed the defects in a heavy chromium deposit and you showed a perfectly flat surface with the steel. Is this a condition you normally find or do you find that the defects in

the chromium are more frequently picked up from the defects in the steel? They may be minute in the steel and not visible macroscopically, but they are there.

DR. SEYB: The slide showing the filled-in crack pattern on an electrodeposited chromium surface was for chromium with sufficient thickness so the crack pattern would be characteristic of the deposit and would not be a result of minor variations or microscopic defects in the base metal.

MR. RALPH W. MOELLER (Pratt & Whitney Aircraft, East Hartford, Conn.): Was work done at the University of Michigan on your CR-110 solution a year or so ago that showed the heavier deposits had higher stress?

DR. SEYB: I believe you are referring to fatigue tests not stress tests, is that right?

MR. MOELLER: There are several things that I have in mind. One is fatigue tests, and another is a magazine article in which it was said fatigue tests were better with more highly stressed deposits.

DR. SEYB: You are introducing a different but related subject; that is the fatigue properties of chromium plated steel. We expect to publish another paper on the subject giving additional information on the relation of stress and fatigue when this study is completed.

However, in answer to the first question relative to the fatigue properties of CR-110 deposits as given in the Michigan report, the results showed approximately the same fatigue limit for 10 mils as for 1 mil thickness. This fatigue result ties in with the stress curve for this deposit (Fig. 5). Since compressive stress is obtained for thicknesses greater than 2 mils, the increased thickness did not have the usual bad effect on the fatigue limit of the steel.

With reference to the other report you mentioned, which might not be familiar to many people here, the difficulty may be connected with the steepness of the stress versus thickness curve for thin deposits. If stress were measured at only one thickness in this region, it is possible to obtain high tensile stress for deposits that at greater thicknesses show compressive stress.

MR. MOELLER: Do you feel that we are premature in eliminating the bake for hydrogen embrittlement at 375° F except in highly stressed parts that are baked at 750° F?

DR. SEYB: That would depend on which is more important, fatigue or embrittlement, two quite different things.

MR. MOELLER: Do you feel the effects of removing the embrittlement are greater than the detrimental effect that you may get by leaving it in the low bake?

DR. SEYB: That would depend almost exclusively on the particular part—its shape, size, and ultimate use.

MR. W. B. STEPHENSON, JR. (General Electric Company, AGT Division, Cincinnati, O.): Going back to stressed chromium, it would seem that if one has an unstressed chromium deposit that is full of cracks, these cracks are a good focal point for fatigue failure. It appears that one is between the devil and the deep blue sea, whether to have a highly stressed deposit with no cracks or a low stress deposit with a lot of cracks. What we should aim at is a crack-free deposit with very little stress.

I have seen recently a report by one investigator who had plated chromium at 168° F and claimed a practically zero stress. Have you done any work on that temperature range?

DR. SEYB: First of all, I would like to discuss the crack pattern in chromium deposits. As was shown in the photomicrograph in this paper, the cracks in chromium deposits are filled in by later deposition and hence only the microscopic surface cracks remain open. Thus, it is a mistake to visualize the healed-over crack pattern of chromium deposits as being deep open cracks that would give the notch effect. Our fatigue data have demonstrated experimentally that the filled in crack pattern in chromium deposits are not acting as notches in fatigue tests.

In regard to the second statement, I am not familiar with the reference you mention. The Bureau of Standards low contractile chromium deposited at 185° F was originally referred to as low stress chromium, but on later examination was found to have relatively high stress.

MR. WILLIAM P. INNES (Technical Director, McDermid, Inc., Waterbury, Conn.): Have stress measurements been made on crack-free chromium?

Mr. J. O. Almen, formerly with General Motors Corporation Research Laboratories and now retired, once stated that the width of cracks was a measure of tensile stress. I feel that your compressive values here are due to the cracking that would cause a compressive value particularly in heavy deposits as measured by the Phillips and Clifton method. The chromium deposit itself probably has a tremendous tensile stress (150,000 psi). I don't think you can use the methods you employed when cracking occurs.

DR. SEYB: Although stress measurements were not made on crack-free chromium, it is thought the stress would be relatively high since no stress relief by cracking occurs.

It is difficult to see how a deposit still possessing a tensile stress of 150,000 psi can give a compressive stress as you infer. When a crack forms due to high tensile stress some stress is relieved, but no expansive force is introduced by this stress relief. When cracking occurs thousands of times in an inch then the average stress for a deposit could conceivably approach zero due merely to stress relief. The experimental facts, as shown in Table I, are that stress does decrease with increasing number of crack-lines, but that when enough crack lines are present the stress crosses the zero axis and becomes compressive, thus actual expansive forces are exerted in some way by the deposit. The postulated mechanism given in this paper for the compressive stress involves the relief of tensile stress through cracking and the introduction

of expansive forces by redeposition of chromium in the cracks as schematically illustrated in Fig. 8.

With reference to the discussion on measurement of stress, I would like to point out that ever since the classical work by Stoney in 1909, the direction of stress in an electrodeposited coating has been determined experimentally by the direction a thin metal strip is bent when plated on only one side. If the plated strip remains straight, the deposit is said to be free of stress. If the strip bends concavely with respect to the deposit, the stress is tensile. If the strip bends convexly with respect to the deposit, compressive stress is present. This general concept has been used extensively for the determination of stress in electrodeposits. Neither the classical methods of stress measurements nor the modified methods used in this study give internal stress in a small segment of a deposit, but rather the average stress exhibited by the overall deposit, including the chromium between cracks and that deposited inside cracks. Not only the rigid flat strip but also the spiral contractometer showed compressive stress for certain chromium deposits on the basis of these generally accepted criteria.

Mr. Charles A. Forbes (Rockwell Spring and Axle Company, Coraopolis, Pa.): Do thin decorative chromium deposits on buffed copper or nickel also show a reduction in stress with increased thickness, as you have illustrated for heavy chrome deposits.

Dr. Seyb: The stress in decorative chromium increases with thickness until the tensile strength of the deposit is exceeded, which results in the formation of cracks. The stress then decreases with further increase in thickness, as is shown in the stress vs. thickness curves for heavy chromium deposits.

Mr. Wm. Marcovitch (American Machine and Metals, Sellersville, Pa.): The curves shown indicated that greatest stress seemed to occur at thinnest deposits, the thickness characteristic of decorative chromium. What effect can these highly stressed thin deposits have on the failure of nickel chrome deposits by cracking?

Dr. Seyb: The stress in decorative chromium deposits has an important effect on cracking, which in turn is important in corrosion resistance. For thin plates stress increases until it is high enough to produce cracking. Then as thickness increases these cracks fill in by further deposition and stress decreases. Corrosion resistance of the coating is known to be poor at the thickness where cracking begins since the cracks are left open at this thickness. Corrosion resistance is better with thinner plates before cracking occurs and also with increased thickness after the cracks fill in by further deposition. It is important to note that the CR-110 deposit shows healed-over cracks with exceptionally thin deposits (stress is dropping sharply). This fact may account for its improved corrosion results in decorative applications. On the other hand, crack-free chromium exhibits good corrosion properties because cracks are not present.

Mr. Glendel E. Monroe (Lane Plating Works, Dallas, Texas): What are the factors that tend to lead to pitting and roughness in heavy build up (0.050 inch) of chromium on steel?

Dr. Seyb: Pitting and roughness in deposits as thick as you mention could be due to a number of factors including the base material, smoothness, cleaning, plating solution, and plating conditions, in other words, any factor in the whole finishing operation. Since a discussion of such a subject could be quite lengthy, we would appreciate specific information about the difficulty so that the question may be answered more completely.

TRICKS of the TRADE

Readers who have developed a special technique for making a particular job simpler or more efficient are invited to submit their "tricks" to the Editor, Plating, 445 Broad Street, Newark 2, N. J. Plating will pay $10.00 for each "trick" that is published.

Good-By to Oil Spotting by Stanley J. Beyer

In my early years of learning the practical phases of electroplating, it was regular practice to skim oil off of all acid solutions each morning with tissue paper. This skimming process included the cold or warm Watts nickel baths. In spite of this, the elimination of oil spots under the plated surface was a constant problem. With the introduction of organic bright nickel solutions, with their powerful wetting agents, oil disappeared from the nickel solution, but oil spotting continued until I caught on to the following trick of the trade: add a small amount of wetting agent suitable for acid solutions to all acids in the cleaning cycle before plating. The same wetting agent used for your bright nickel plating solution is excellent, particularly in the acid dip before nickel plating. Then say good-by to oil spotting.

EQUIPMENT FOR THE STUDY OF ELECTRODEPOSITION ON OXIDE-SOILED SURFACES*

HENRY B. LINFORD† AND DAVID O. FEDER‡

This report gives details of construction of the equipment necessary to study the results of electroplating on oxide-soiled basis metals. Essentially the equipment consists of a three-compartment dry-box, designed so that all experimental work may be conducted in a helium atmosphere that is substantially free of moisture and oxygen. In one compartment is vacuum-furnace equipment for the preparation of clean (oxide free) metal specimens and for controlled oxidation of these specimens. One compartment is primarily a plating shop. The third compartment is a microbalance area. The auxiliary equipment necessary to maintain the dry, oxygen-free atmosphere is described.

Introduction

A metal that is about to be covered by an electrodeposited coating usually enters the plating bath with some inorganic contaminants, especially oxide, on its surface. Since this oxide often causes substandard plates, Research Project No. 12 has been studying the effects of electroplating onto metal surfaces contaminated by oxide films.[1] In particular the project is attempting to discover the mechanism by which plating occurs onto such an oxide-soiled cathode. Several mechanisms appear possible:

1. The oxide is covered by the plated metal and remains intact under the plate.
2. The oxide is reduced, chemically or electrochemically, during the plating process.
3. The oxide is dissolved by the plating bath.
4. The oxide is mechanically displaced during the plating operation.

Needless to say, it is recognized that the particular system under consideration will influence which mechanism occurs.

Experimental Method

The present paper describes the proposed experimental approach to the problem and gives a detailed description of the equipment that has been constructed to provide the necessary data.

It seems clear that any experimental technique that attempts to elucidate the actual mechanism of plating onto an oxide-soiled cathode should involve the following steps:

1. Preparation of a clean, that is, an oxide-free metal surface.
2. Formation of oxide films of known thicknesses on the cleaned specimen.
3. Electroplating onto the oxide-coated specimen.
4. Evaluation of the mechanism of plating.

The experimental method used to achieve these results must satisfy several requirements:

1. The thickness of the oxide film must be determined by a method sensitive to at least one monolayer of oxygen and capable of measuring oxide films up to several thousand angstroms in thickness.
2. The plated specimen must be evaluated by a method of similar sensitivity and range as in No. 1 above, but with the additional requirement that the method must allow the mechanism of plating to be determined.
3. The entire experimental procedure must be capable of operation in an inert atmosphere, substantially free of oxygen and water.

A thorough survey of the literature led to the conclusion that a method using a microchemical balance with a sensitivity of one microgram would come closest to fulfilling these requirements. The principal part of the experimental work must be done in a controlled atmosphere. Therefore, as described in the next section, a dry-box operating with purified helium is employed in the steps described below:

1. Cleaning of the Surface

A degreased copper specimen is placed in vacuum apparatus and heated, outgassed, and reduced with hydrogen. After several cycles to insure freedom from oxides, the system is re-evacuated and helium admitted to break the vacuum. The cleaned specimen is then transferred to the microbalance and weighed.

*Presented at the Forty-First Annual Convention of the American Electroplaters' Society, 15 July 1954.
†Professor, Department of Chemical Engineering, Engineering Center, Columbia University, New York.
‡Project Fellow, AES Research Project No. 12.

TABLE I. PLATING ONTO OXIDE-SOILED CATHODES: DIFFERENTIATION AMONG THE VARIOUS POSSIBLE MECHANISMS

Possible Mechanism	Final Weight / $Wt_{Cu}{}^a + Wt_{oxide}{}^a + Wt_{Ni}{}^b$	$Wt_{Ni}{}^b$ on Duplicate Specimen / $Wt_{Ni}{}^b$ on Oxidized Specimen
1. Oxide remains intact under plate	1	1
2. Oxide reduced during plating	<1	>1
3. Oxide physically displaced or dissolved	<1	1

[a]These weights obtained from microbalance.
[b]These weights obtained by analysis of metal stripped from specimen.

2. Soiling with Oxide

After weighing, the clean specimen is again placed in the vacuum equipment and outgassed. Oxygen is then admitted at a definite temperature and pressure and for a predetermined time. Variation of the oxygen pressure, temperature, and time of oxidation allows varying thicknesses of oxide to be formed. The system is evacuated, helium admitted, and the specimen transferred to the microbalance and reweighed. The weight difference from No. *1* above determines the amount of oxide formed.

3. Plating the Oxide-Coated Specimen

After weighing, the oxide-coated specimen is transferred to a nickel plating bath, where a definite weight of nickel is deposited on the specimen. After plating, the specimen is rinsed, dried in vacuum, and then transferred to the microbalance and reweighed.

4. Coulometry

A duplicate sample that has not been oxidized is plated in series with the specimen. In addition, a coulometer in series with these two specimens determines the actual amount of current passed.

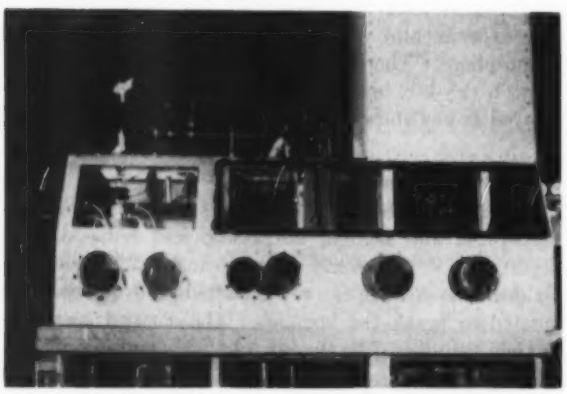

Fig. 1. Front view of dry-box: vacuum-furnace section at left, plating compartment in center, and microbalance area on right

5. Analysis

Finally the plated metal is stripped from the specimen and analyzed by colorimetric means. This is done outside the dry-box.

These various measurements should permit determination of the mechanism by which plating has occurred (Table I).

Equipment

In order to enable the experiments described above to be performed in a controlled atmosphere, a helium filled dry-box was constructed. A circulation and purification system was built to insure the continuing purity of the helium atmosphere. Finally a high vacuum system was built for the purpose of cleaning and oxidizing the copper specimen, as well as to allow determination of its surface area.

Dry-Box

The dry-box is essentially a pressurized gas-tight chamber filled with circulating helium and containing in essence three small-scale laboratories, namely, a vacuum-furnace compartment, a plating compartment, and a microbalance compartment. Manipulations within the box are performed from outside by means of arm length rubber gloves extending through the walls of the box. The box, 6x2x2 feet, is made of aluminum faced plywood panels, wood-screwed to an aluminum painted wooden frame, and gasketed with a soft vacuum wax, Apiezon "Q". The top and front panels are Lucite, attached in the same manner.

A front view of the box, with the vacuum-furnace area on the left, plating area in the center, and microbalance area on the right, is shown in Fig. 1.

In the vacuum-furnace area is a demountable quartz tube (see Fig. 2), which connects to a high vacuum system outside of the box by means of pyrex tubing passing through the top of the dry-box. The metal specimen is placed in the quartz tube for outgassing, cleaning, and oxidizing. To heat the specimen for these operations, a water-jacketed resistance furnace may be raised into position surrounding the quartz tube by means of a hydraulic jack, filled with diffu-

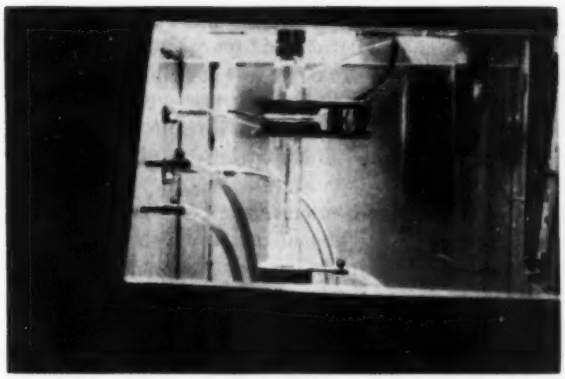

Fig. 2. Quartz vacuum-furnace tube. Water-cooled resistance furnace has been lowered out of position

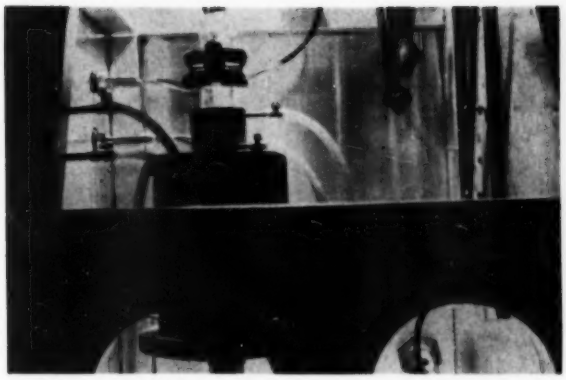

Fig. 3. Vacuum-furnace compartment. Water-jacketed resistance furnace surrounds quartz vacuum-furnace tube. Part of hydraulic jack is visible through left glove port

sion pump oil, and operated from outside the box. The furnace and jack are visible in Fig. 3.

Also entering into the vacuum-furnace chamber is a double-door emergency entrance port, used for introducing articles into the box without causing serious contamination of the box atmosphere. This port is equipped for evacuation and flushing with helium.

In the plating compartment are two glass-covered plating tanks which are, in effect, vacuum dessicators (see Fig. 4). The bottom of each of these tanks is joined to 20 mm tubing that passes through the floor of the dry-box where it is connected to pressurized storage tanks of plating solutions, rinse water, to a drain tank, and to a rough vacuum system. Thus, once the specimen is in place and the tank covered, plating solution can be introduced and drained, the specimen rinsed and dried in vacuum without exposing the box atmosphere to any moisture contamination from the plating set-up. The plating rack is made of nylon and is designed to handle the cylindrical specimen 4 inches long, 7/8 inch i. d., and 0.003 inch wall thickness.

The balance area contains an Ainsworth model No. FDJ microbalance (see Fig. 5), which has a load capacity of 20 gm and a sensitivity of 1 microgram at full load. Since such a microbalance is extremely sensitive to shock, temperature fluctuations, and static electricity, precautions have been taken to minimize these effects.

The balance is mounted on a specially designed platform consisting of two lead slabs separated by a layer of sponge rubber and resting normally on three small screw jacks, whose motions are synchronized by an endless chain passing over sprockets on each jack. When the balance is to be used, the jacks lower the lead platform holding the balance onto a support made up of 16 rubber handballs arranged in four tetrahedra of four balls each. This support provides a relatively vibration-free foundation for the balance.[2]

Temperature fluctuations are minimized by having the incoming circulating helium enter the box at a constant temperature which approximates human body temperature, so that the presence of the operator will have negligible thermal effect on the balance.[3]

Static electricity is minimized by a strip of polonium

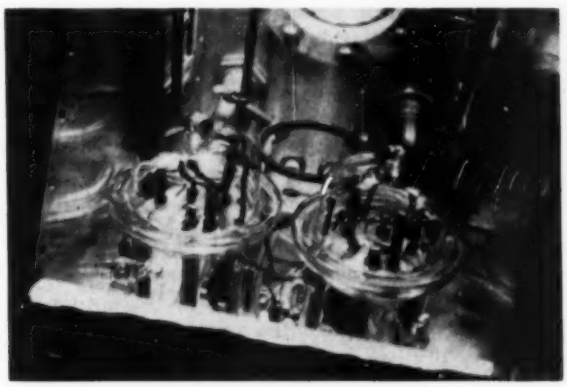

Fig. 4. Plating compartment. Glass plating tanks are shown in foreground with part of glove port visible at rear

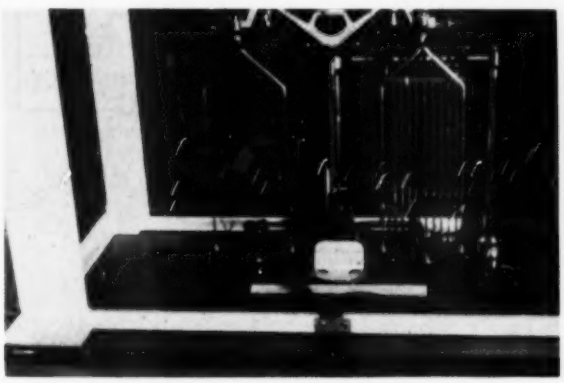

Fig. 5. Microbalance: viewed through the front of the box

Fig. 6. Sliding intercompartment door assembly. Inflated rubber gasket is visible at top of door. Slightly to the right of the gasket a ball-bearing "trolley" is set in a "trolley barn"

foil mounted in the balance case and grounded outside the box.

The specimen is transferred from one compartment to another by means of a magnetic trolley. A magnet outside the box holds a steel ball-bearing race in position on the inside ceiling of the box. The specimen is hung on a hook soldered to the ball-bearing race. Moving the magnet outside the box causes the trolley inside to follow. By this means specimens are transferred from one compartment to another. The compartments are connected by double-doored vestibules. Sliding aluminum doors (see Fig. 6) with inflatable rubber gaskets seal one section from the other to localize any contamination that might occur.

In addition to the equipment described, the dry-box also contains various bulkhead seals for introducing cooling water to the resistance furnace, electricity for various uses, helium into the plating solutions, and glove ports for sealing the gloves to the box.

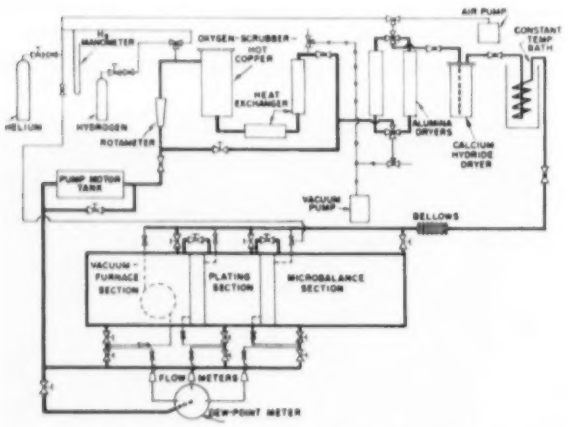

Fig. 7. Diagram of circulation and purification system

Circulation and Purification System

The helium circulation and purification system is designed to circulate 10 cubic feet per minute of helium and continuously remove all but traces of oxygen and water from this gas. The system is made of 1-inch i.d. copper tubing with sweat fittings used throughout (see Fig. 7).

After leaving the bottom of the box, the helium gas passes into a gas-tight cylinder in which are housed the circulating pump and motor. Sealing the pump and motor in the tank prevents leakage of helium along the pump driveshaft.[4] The gas then passes from the tank through a rotameter into a hot copper furnace that removes any oxygen impurity.

The oxygen scrubber is a stainless steel tube, 2 feet long, 6 inches in diameter, filled with 5/8 inch lengths of $\frac{5}{8}$ inch copper tubing.* The lower one foot of this stainless tube rests in a 6 KW globar furnace and is heated to 500°–600° C to effect removal of the oxygen (see Fig. 8).

The gas next passes through a series of heat exchangers and then into a twin tower activated alumina drier that removes most of the water. After this the gas is thoroughly dried over calcium hydride and then passes into a coil immersed in a constant temperature bath set at about 37° C, and constant to better than ±0.1° C. From here, the gas goes into the box at a constant temperature so as to minimize thermal effects on the microbalance.

At the exit of the box, a by-pass arrangement allows the helium from each compartment to pass separately through small flowmeters into a dew-point meter, which is maintained at −80° C with dry ice and acetone.† This meter serves as a quality control of the dry-box atmosphere. As long as no dew spot appears at −80° C, the atmosphere may be considered sufficiently pure for use. Appearance of a dew spot serves as a warning of contamination, which may then be localized. (The reactivity of an inert atmosphere with an −80° C dew point has been calculated to be equivalent to a vacuum of $<10^{-6}$ mm.[5])

The box and entire circulation system are pressurized to 1–2 cm of the water, positive pressure. At this pressure, the entire system shows a leakage rate of about 0.002–0.004 ft³/min. This loss is continually replaced by bleeding a small stream from a helium tank. Thus the entire system is maintained at this positive pressure whether or not the circulation system is being operated.

Vacuum System

In order to be able to outgas, clean, and oxidize the specimen, a high vacuum system is connected to the vacuum furnace previously described. Except for the furnace tube itself, the entire vacuum system is outside of the dry-box.

*Courtesy American Brass, Inc., Waterbury, Connecticut.
†Dew-point meter silver plated courtesy Sylvania Electric Products, Inc., New York.

The system (see Fig. 9) is activated by an Eimac oil diffusion pump backed by a Cenco Megavac mechanical pump and consists of the usual arrangement of liquid air traps, mercury cutoffs, and gauges. The system in addition to evacuating the vacuum-furnace tube also serves as a gas dosing system, whereby hydrogen and oxygen are introduced into and removed from the furnace tube for oxide reduction and oxide formation, respectively. These gas handling systems are also shown in Fig. 9.

The vacuum system is designed to produce a vacuum of at least 10^{-6} mm mercury. A combination of mercury manometer, thermocouple, and ionization gauges serves to measure the actual vacuum obtained.

This, then, is the equipment that was built to perform the following functions:

1. Produce a substantially oxide-free metal surface.
2. Form a thin measurable oxide film on this surface.
3. Electroplate onto the oxide-soiled surface.
4. Evaluate the mechanism by which plating has occurred.
5. Enable all manipulations to be performed in an inert atmosphere substantially free of oxygen and moisture.

Description of Specimen

The specimen on which all these operations are performed is a tube of copper, 4 inches long, 7/8 inch i.d., with a wall thickness of about 0.003 inch. The specimen size was so chosen as to provide sufficient surface area to enable the microbalance to detect a monolayer of oxygen. At the same time, the specimen should have a total weight of <5 gm so as to be handled by the balance without loss of sensitivity. This large surface area (>100 cm^2), coupled with the small total weight, accounts for the thinness of the tubing used.

These specimens are prepared from cold drawn copper tubing with 0.012 inch wall.* The tubes are cut to length, annealed, cleaned, and then etched anodically in an aqueous sulfuric acid solution until the wall thickness has been reduced to approximately 0.003 inch.

In conclusion it should be emphasized that although the project initially is attempting to ascertain the mechanism by which nickel is deposited onto an oxide-soiled copper cathode, there is no attempt to limit the project to those metals. In so far as is practical, the technique will be used on a great many combinations of plated and basis metals, in the hopes both of obtaining data useful to the plater and of obtaining an insight into how this mechanism of plating is governed by and may be predicted from the physical, chemical, and electrochemical properties of a basis metal, its oxide, and a metal being deposited.

*Courtesy American Brass, Inc., Waterbury, Connecticut.

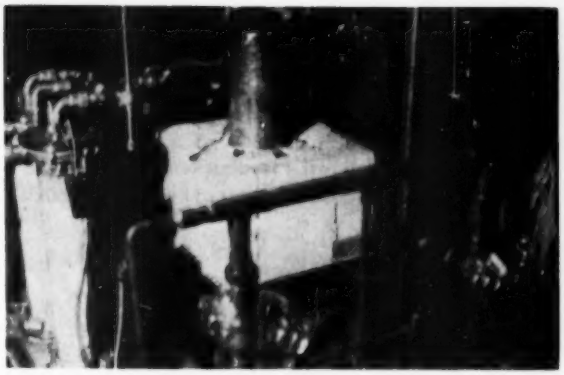

Fig. 8. Stainless steel oxygen scrubber. Stainless tube rests in 6 KW globar furnace. The twin-tower alumina dryer is visible at left

Acknowledgment

The authors would like to express their appreciation to Mr. E. T. Candee, Dr. E. A. Parker, and Dr. E. B. Saubestre of the Project Directing Subcommittee for their continuing interest, helpful criticism, and valuable assistance. Likewise, Mr. J. M. Sherfey of the Electrodeposition Section of the National Bureau of Standards contributed sound and timely advice on the design and construction of the dry-box and circulation system.

Finally, we are indebted to Mr. G. Trost and Mr. K. Schumann, whose interest, suggestions, and fine workmanship have proved invaluable.

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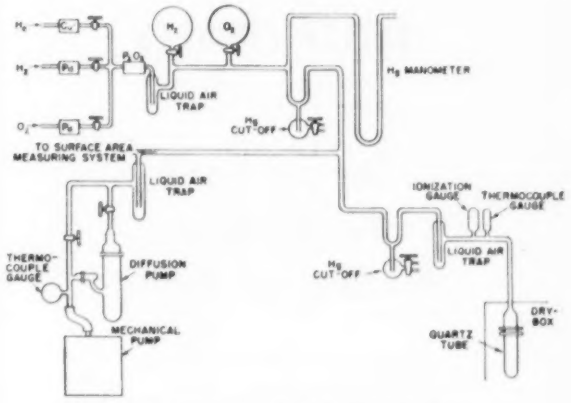

Fig. 9. Diagram of high vacuum system

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Book Review

DR. HAROLD J. READ

Professor of Metallurgy,
The Pennsylvania State University

ORGANIC COATING TECHNOLOGY—Vol. I, Oils, Resins, Varnishes, and Polymers, by Henry Fleming Payne, 1954, ix + 674 pages. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price, $10.00.

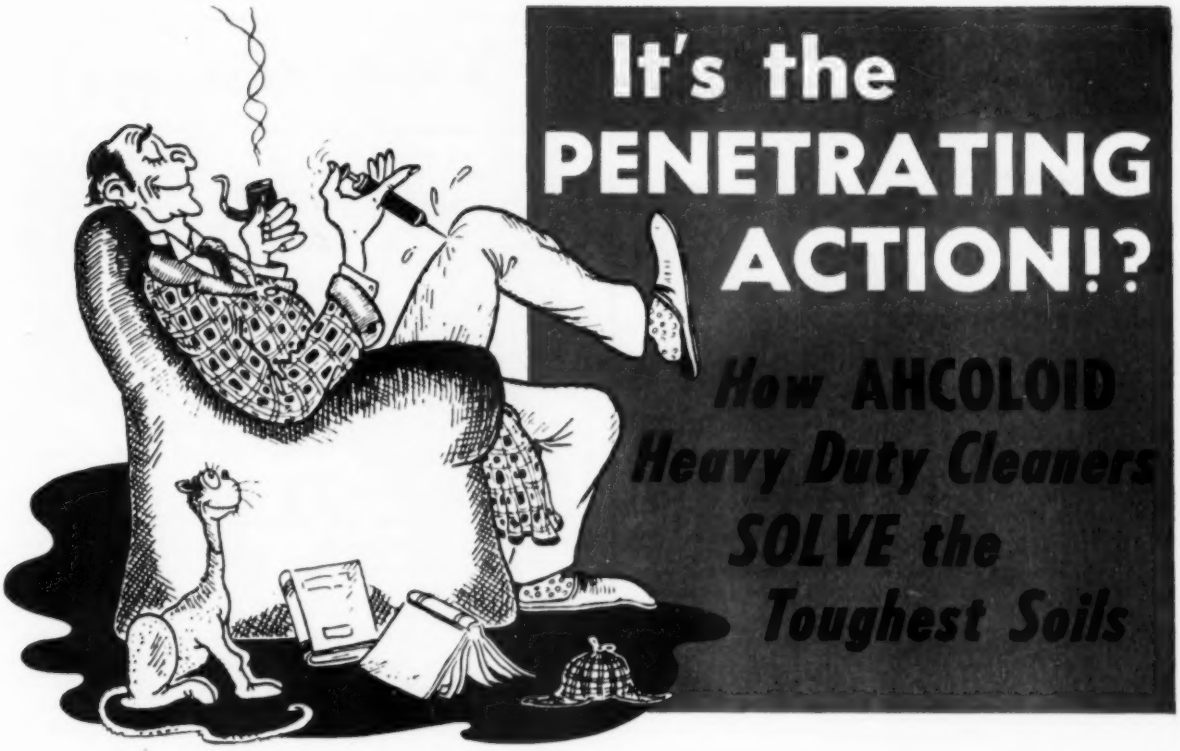
It is not surprising that several books on the general subject of organic coating technology have appeared during the last few years. The ever-growing and increasingly important developments in this field justify thorough and extensive literature treatments. There have also been many recent developments, often of diverse nature, which require new surveys and reorganization of the information presently available. Professor Payne's contribution, at least as exemplified by Volume I, is an important one. He has organized with skill and presented with clarity a tremendous amount of information in a gratifyingly concise form.

The volume under review is concerned only with the materials used in the preparation of organic coatings, the formulation of coatings, and appropriate test methods within this field. After presenting a concise but comprehensive chapter on the fundamentals of film formation, the author devotes his attention in subsequent chapters to the oils, resins, driers, volatile solvents, and plasticizers that serve as the raw materials for coating formulations. Within each chapter the selection and presentation of information fulfills the objective of giving the reader the information that he will require for the proper use of the material being discussed. A certain amount of fundamental information is presented, but the object in doing so appears always to have practical overtones. The more speculative and theoretical aspects of structural data and reaction mechanisms are not brought into discussion.

The chapter on test methods presents concisely the procedures used to determine whether raw materials meet specifications, the coating material is being processed properly during manufacture, or the finished coating material meets specifications and application requirements. The test methods are well identified with regard to ASTM, Federal, and other publications.

Each chapter ends with a group of literature citations that have been keyed into the text. Although these citations are by no means exhaustive, they will be of great assistance in running down minute details in a given field.

This book should prove to be very satisfactory as a manual for new technicians in the paint industry, and it should serve admirably as a reference text for those who have a close interest in the entire broad field of organic coatings.



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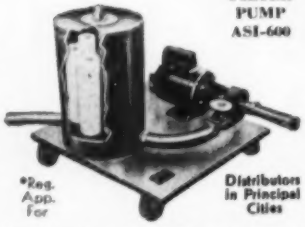

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Practical Colour Matching on Anodic Films. A. E. Bratt. Bull. Inst. Metal Finishing, No. 1, 63–76 (Spring, 1954). Al. Lab. Bull., **25**, No. 6, 372 (June, 1954).

This paper attempts to coordinate existing information with the experience gained in the research laboratory on the selection of the most suitable alloys, methods of anodizing, dyestuff selection and application, and the sealing of aluminum anodic film.

Method of Coating Foraminous Metal With Vitreous Enamel. S. D. Hackley. U. S. Pat. No. 2,676,899, application filed April 4, 1951, patent April, 1954. Al. Lab. Abst. Bull., **25**, 457, (July, 1954).

The method of producing a sheet of foraminous metal (e.g., expanded metal) covered with a continuous coating of vitreous enamel consists in immersing the metal in a vitreous enamel slip of fusible glass constituents and approximately 20 per cent, by weight, of water and withdrawing the sheet. The openings in the sheet should be of such a size that a continuous coating of the slip extends across each and the thickness of the coating in the openings is such that after fusing it is of less thickness than the over-all thickness of the sheet. Immediately after the sheet has been withdrawn from the slip, and before the coating has become dry, the coated sheet is subjected to a sufficiently high temperature for a sufficient length of time to fuse the coating, then cooling the coated sheet while the coating still extends across the openings so that the film of material in all of the openings remains continuous.

Anodic Oxidation of Aluminum and Its Alloys. M. Schenk. Soc. Roy. Belge Ing. Ind., No. 6, 267–269 (Dec. 1953). Al. Lab. Abst. Bull., **25**, 454 (July, 1954).

The appearance of the film depends on the anodizing procedure used, the receptivity of the metal, the surface preparation, and the film thickness. The purer the metal the more brilliant will its appearance be. Electrolytes of oxalic or chromic acid base change the initial appearance of the metal. The freshly produced film being microporous can absorb colouring products, generally organic dyes. To protect the film, coloured or not, against staining it is necessary to close the pores; this

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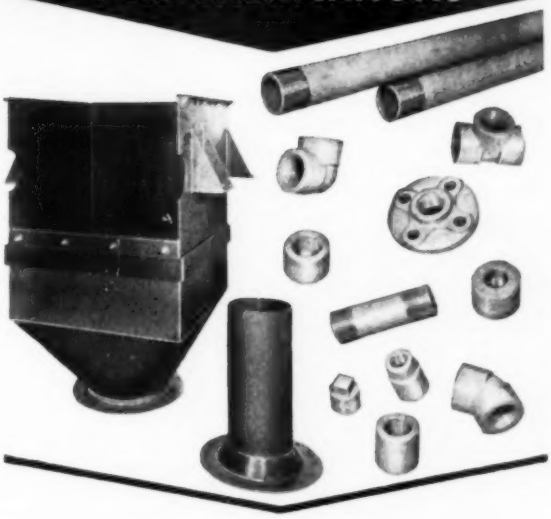

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may be accomplished by immersion in boiling water or in a hot salt solution. The chemical properties of the anodic layer are those of alumina. The anodizing procedure most used is that using sulfuric acid of concentration varying from 10 to 25 per cent in pounds, with D-C current of 10–20 volts and current density of 1–3 amp per square decimeters; the temperature of the bath varying between 15° and 25° C.

Pretreatment of Aluminum Foils for Electrolytic Condensers. Austrian Patent 178,681, June 10, 1954. C. A., **48**, 8160 (July 25, 1954).

In the pretreatment of aluminum foils for use in electric condensers, the etched foils are washed in boiling water to remove traces of chlorine left by the etching process. To avoid chemical oxidation of the foils during the washing and to passivate them, an inhibitor, for example sodium silicate, is added to the wash water.

Mirrolike Finished on Aluminum. E. R. DuFresne and J. R. Swihart. U. S. Pat. 2,673,143, March 23, 1954. C. A., **48**, 7528 (July 10, 1954).

Bright etching is done in approximately 1.5 minutes at 160°–204° F in an aqueous bath containing 6 pounds per gallon NaOH, 1 pound per gallon sodium gluconate, and 1–1.25 pounds per gallon $NaNO_3$. Substitutes for $NaNO_3$ are $NaClO_3$, $NaNO_2$ and NaClO. Substitutes for sodium gluconate are polyhydric alcohols of CH_2OH-$(CHOH)_aCH_2OH$, where a is at least 4; and salts and lactones of COOH $(CHOH)_bCH_2OH$, where b is at least 2.

Electropolishing by Alternating Current: II, Aluminum. Fumio Hine. J. Electrochemical Soc. Japan, **17**, 52–3 (1949). C. A., 48, 8086 (July 25, 1954).

Electropolishing of aluminum by alternating current was studied. The composition of electrolyte was: concentrated H_2SO_4 50 cubic centimeters, citric acid 35 grams, H_2O 45 cubic centimeters. Counter-electrodes were of steel, iron, nickel, lead, or carbon, lead being the most effective. The optimum temperature was 50°–70°. Aluminum of low purity and aluminum alloys gave better results than aluminum of high purity.

The Adhesion of Paints to Aluminum (Part I). Dr. K. Broeckmann. **Aluminum, 30,** 279–282 (July, 1954).

Lacquering and painting of aluminum are often regarded with skepticism, because many of the usual lacquers and paints have insufficient adhesion unless the material is pretreated. Although, under certain circumstances, the adhesion can be raised by the various well-known chemical and electrochemical methods of surface treatment, such treatments are relatively time-consuming. The various lacquer bases in use at present differ in their adhesion to aluminum, and it has been the object of the investi-

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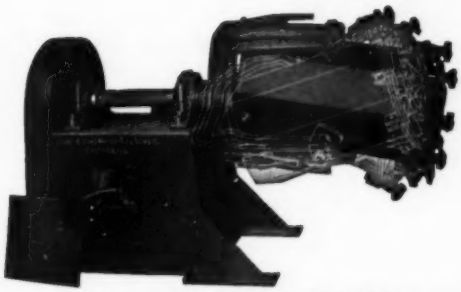

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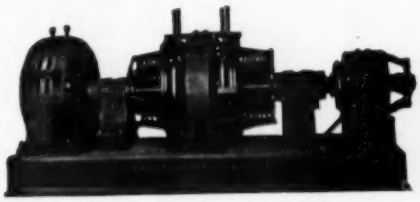

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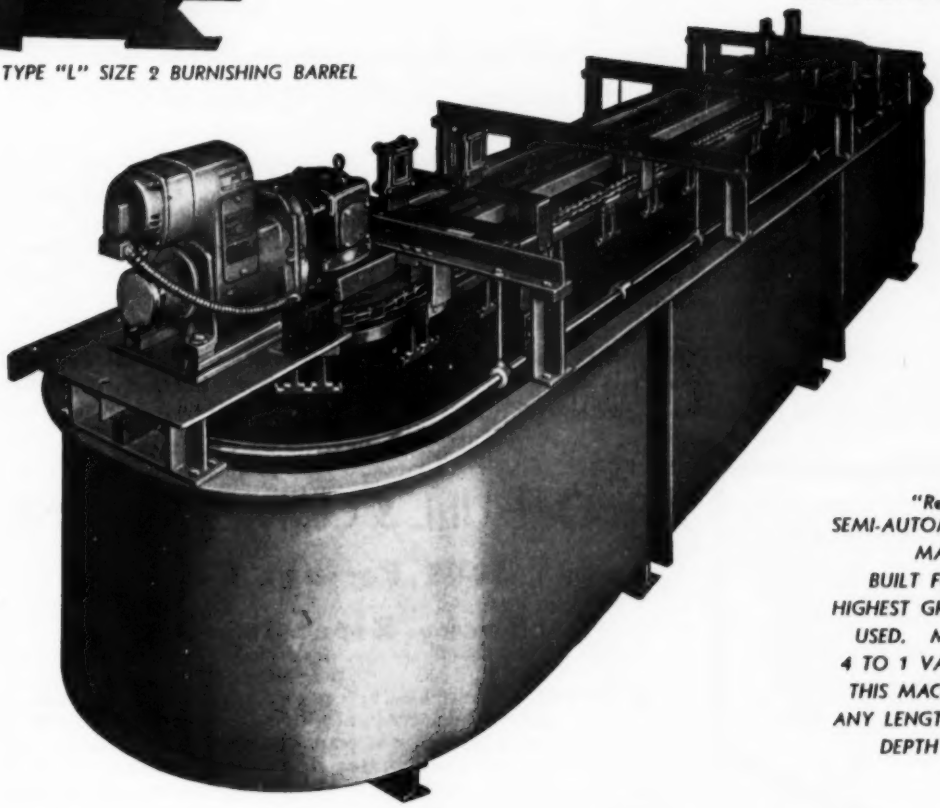

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gation reported here, to elucidate the reasons for these differences. After describing the experimental conditions and test methods used, the paper shows that lacquer films containing hydration centers which have the best adhesion produce measurably thicker oxide layers on aluminum than those with poor adhesion, so that not only adhesional forces but also chemical reactions with the adhesion-favouring lacquer bases are responsible for adhesion to the aluminum surface.

The Diffusion of Addition Elements (in Particular of Copper) into the Coating of Clad Light Alloys. M. Renouard. Rev. de Met., **51**, 419–424 (June, 1954).

Specimens of clad Duralumin have been taken at various stages during manufacture, and the diffusion of copper into the coating has been determined spectrographically. The results agree well with those of previous experiments. It was not possible to reveal the supposed effect of grain size of the cladding materials on the diffusion of copper for lack of specimens having a sufficient range of grain-sizes.

The coefficient of diffusion of copper in A5 aluminum appeared to be of the order of 5–8 x 10^{-4} mm^2/hr at 500° C. The thickness of cladding required to safeguard against any marked diffusion is in the region of 70 μ, but thicknesses slightly less than this can be used without serious danger.

Zinc Immersion Bath for Electrocoating of Aluminum. W. G. Zelley. U. S. Pat. 2,676,916, April 27, 1954. C. A., **48**, 8091 (July 25, 1954).

Usual zincate baths (for example 100 grams ZnO and 400 grams NaOH per l.) yield more uniform, dense, and adherent zinc deposits on aluminum and an improved eventual electroplate when about 0.2 grams of iron, cobalt, or nickel per l. and 2.5–50 grams per l. of tartarate (or tannate or sugars) are present.

The ferrous metals form negative hydrous oxide solids. By using such solutions, cleaning procedures can be minimized and a still further improvement can be obtained if the first zinc coat deposited is stripped in HNO_3 and the aluminum object is then recoated with zinc.

The Diffusion of Aluminum into Oxidized Copper. J. Cournot. Cuivre, Laiton, Alliages, **13**, 51–54 (1953). Met. Abst., **21**, 913 (July, 1954).

Cournot describes researches carried out to determine the degree of diffusion of a layer of aluminum powder cemented on to the surface of copper articles as a protection against attack by fuel gases. Contrary to previously accepted ideas, it was found that under certain conditions penetration was considerable, leading to some interesting phenomena, including the reduction of cuprous oxide by aluminum.

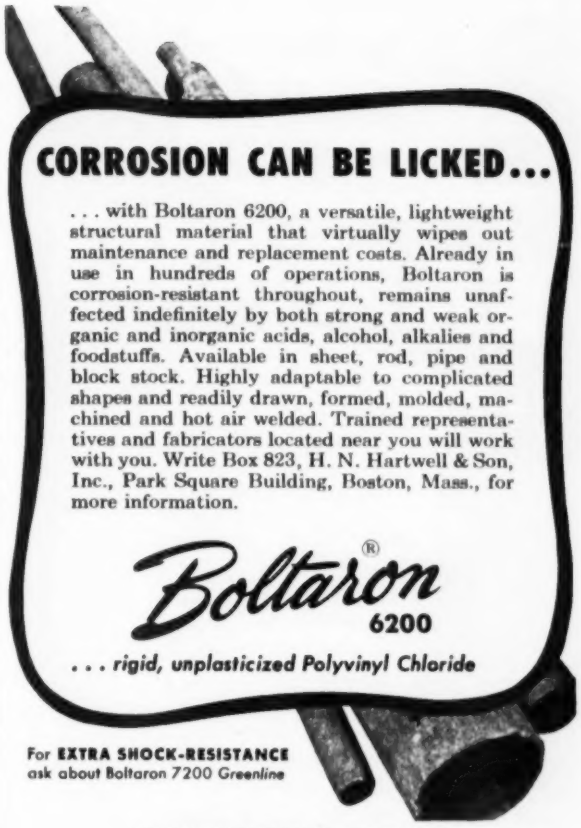
Studies of the Conditions of Growth of Anodic Aluminum Oxide Films. J. Herenguel and P. LeLong. Rev de Met., **51**, 411–418 (June, 1954).

By the use of interferometric methods on selected polycrystalline specimens of aluminum and high-purity aluminum 3 per cent magnesium alloy, the authors have studied the increase in thickness of the Al_2O_3 film formed as a result of anodic oxidation and have measured its refractive index.

The thickening of the film is shown to be an increasing function of the rate of oxidation, varying, for example, from 39 per cent 0.5 amp/sq dm to 76 per cent at 20 amp/sq dm. The nature of the electrolyte affects this slightly, but the orientation of the crystal face, the nature of the metal, the time of treatment, and the temperature of the electrolyte appear to have little or no effect.

The refractive index of the film has been found to be independent of all these factors. It is about 1.58 for a wave-length of 0.589 μ.

These measurements contribute to our knowledge of the method of growth and the properties of the anodic Al_2O_3 film.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No. 2,680,079—Method for Making Sheet or Web Material—W. C. Huebner, assignor to the Huebner Company, June 1, 1954.

In the description a new term, "electromigratetics," is introduced as "The science of subjecting compositions in liquid, semi-liquid or mobile liquid particle form and containing magnetically responsive materials or materials rendered magnetically responsive by being electrically charged and ionized to electromagnetic force to cause the migration of the compositions from a retaining element to a receiving surface by the lines of force of the magnetic field or fields of said electromagnetic force and under substantially atmospheric conditions."

The claim covers a method for making webs, sheets, or coatings based on maintaining an electromagnetic field across the zone of the web to be formed and inducing electrostatic charges upon the film of composition on the retaining element and on an intercepting member to cause migration of the composition from a retaining element across an atmospheric gap, thus rendering the composition responsive to the electromagnetic field. Finally the composition is solidified by air currents.

1 claim, 6 figures.

No. 2,680,081—Silicate Impregnation of Porous Coatings—W. A. Sutton and F. Cork, assignors to Rolls-Royce, Ltd.

The claim covers the impregnation of aluminum and magnesium base alloys with a solution of water glass, 45–55 parts by volume (Na_2O:SiO_2 ratio being 1:2) containing 6.5–7.5 per cent by weight chromic acid and 4.5–5.5 per cent by weight potassium chromate. The specific gravity is 1.45–15 at the operating temperature of 95°–100° C.

1 claim.

No. 2,680,678—Method of Chemically Polishing Nickel—L. P. Fox, assignor to Radio Corporation of America, June 8, 1954.

This method of chemically polishing nickel involves treating the nickel with a solution consisting of 60–70 per cent by volume glacial acetic acid, 40–30 per cent by volume concentrated nitric acid, and about 0.5 ml of concentrated hydrochloric acid per 100 ml of solution at room temperature for 15 to 30 seconds.

3 claims.

No. 2,680,695—Process of Silver Coating Plastic—J. S. Judd, assignor to Lyon, Inc., June 8, 1954.

It is claimed that a flexible mirror may be made on a flexible plastic resin sheet by soaking a transparent water-absorptive plastic sheet in water, cleaning by scrubbing with potassium hydroxide, rinsing with water, activating with a tin chloride solution, then in flat form silvering with an alkaline silver nitrate sugar solution. Following the deposition of a second silver coating, the mirror is protected by a sprayed film of flexible butadienestyrene copolymer lacquer.

3 claims.

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No. 2,680,710—Method and Apparatus for Continuously Electroplating Heavy Wire and Similar Strip Material—H. Kenmore and W. Mason, assignors to Kenmore Metal Corp., June 8, 1954.

A method for plating wire equivalent in cross section at least to 75 mil round wire by forming a series of adjacent coils and propelling these coils or helixes through the plating solution.

11 claims, 8 figures.

No. 2,680,711—Deposition of Copper by Immersion—George Norwitz, June 8, 1954.

A process for the immersion deposition of copper on aluminum alloys is claimed consisting of immersion of the aluminum or alloy thereof in an acidic aqueous solution of a copper salt containing a colloid of the group consisting of gelatin, agar-agar, gum arabic, glue, casein, dextrose, and dextrin within the range of ½–1½ per cent by weight of the solution with the metal on which the copper is being plated being in electrical contact with a piece of iron in the same copper solution.

The composition given in claim 4 is:

Copper sulfate solution, 10 per cent	150–250 ml
Sulfuric acid, concentrated	20– 30 ml
Colloid solution, 5 per cent	150–250 ml

5 claims, 2 figures.

No. 2,680,712—Alkaline Zinc Plating Baths—M. B. Diggin and Otto Kardos, assignors to Hanson-Van Winkle-Munning Co., June 8, 1954.

A process for producing bright zinc electrodeposits is claimed wherein there is added to an aqueous alkaline cyanide zinc solution 2.5 to 9 g/l of a brightener which is a condensation polymer of an aliphatic alkalene polyamine with furfural-sodium bisulfite and formaldehyde. Polyamines mentioned include triethylenetetramine and N-hydroxy ethylenediamine.

3 claims.

No. 2,680,938—Apparatus for Conditioning Metal Sheets and the Like—R. O. Peterson, assignor to the Osborn Manufacturing Co., June 15, 1954.

This invention relates to the conditioning of metal sheets and the like, particularly with respect to the removal of scale, cleaning, and polishing by the cojoint action of a brush and of auxiliary materials such as abrasives. The apparatus is designed to provide a stretching motion to the sheet with a brush engaging the sheet at a convex surface opposite a roll.

11 claims, 16 figures.

No. 2,681,015—Work Transfer Device—J. V. Davis, assignor to the Udylite Corp., June 15, 1954.

The apparatus described is a loading and unloading apparatus which permits the transfer of work from a shop conveyor to a plating conveyor and back to the shop conveyor again. The

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use of a collector bar between the plating machine and the shop conveyor that permits simplification of the shop conveyor and permits the use of the chain therein as the work-propelling means.

5 claims, 3 figures.

No. 2,681,274—Buffing Compound—C. B. F. Young, June 15, 1954.

A buffing compound is claimed, the water dispersible film residue of which can be removed after the buffing operation by contact with water or acidulated water. One claim describes the compound as consisting of an abrasive, sodium carbonate, sodium bicarbonate, calcium carbonate, aluminum sulfate, and a metal carbonate for the development of a film dispensing gas when brought in contact with acidulated water. Another claim describes a method for buffing and cleansing, comprising buffing the article with a water dispersible buffing compound containing an abrasive and a vehicle containing an ester of polyethylene glycol of an organic higher monobasic fatty acid, the ester having a molecular weight between 4000 and 6000 and combined with stearic acid, together with a metal carbonate and bicarbonate. Immersing the article in dilute hydrochloric acid releases carbon dioxide, which assists in removing and dispersing the buffing compound.

16 claims.

No. 2,681,310—Treating Aluminum Surfaces—W. H. Wood, assignor to Harris-Seybold Co., June 15, 1954.

A process is claimed for treating aluminum and alloys thereof to provide a surface having improved texture and moisture receptiveness. The aluminum surface is made the anode in an aqueous solution thereby becoming oxidized after which the article is placed in an aqueous solution of an organic hydrophilic colloid (polyacrylic or polymethacrylic acid) at about 100° C. In the description it is stated that under these conditions a strong bond between the polyacrylic acid and the aluminum occurs.

4 claims.

No. 2,682,101—Oxidation Protected Tungsten and Molybdenum Bodies and Method of Producing Same—M. Whitfield and V. Sheshunoff, assignors to Whitfield and Sheshunoff, June 29, 1954.

This method for protecting tungsten and molybdenum surfaces at elevated temperatures consists in depositing a thin nickel film on the article, heating under nonoxidizing conditions to cause at least partial diffusion of the nickel, then immersing the articles in a bath of molten aluminum to form an aluminum-rich protective layer. The nickel film is described as plated on the tungsten or molybdenum, no procedure being given.

5 claims, 3 figures.

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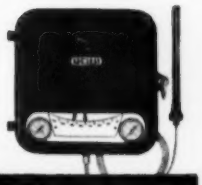

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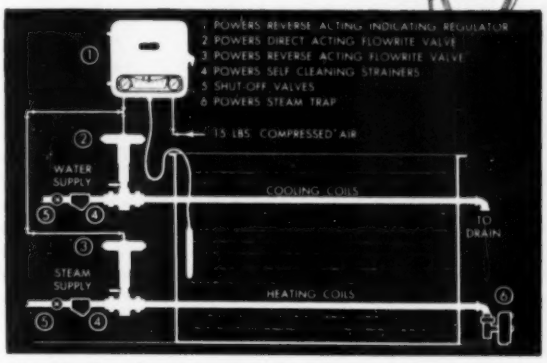

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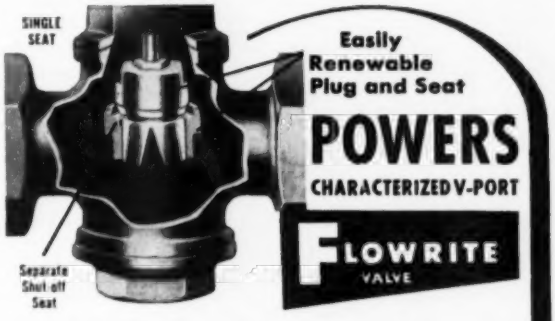

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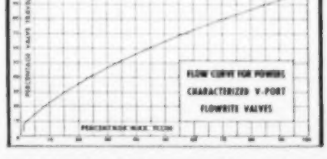

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AES News

Addenda to AES Annual Paper Awards

PLATING regrets the inadvertent omission in the August issue under "Convention Echoes" of the names of two companies and a branch—donors of awards—in connection with the annual paper awards.

The Chromium Plating Award was donated by the Nutmeg Chrome Corporation, West Hartford, Conn. This is the award won by Martin F. Quaely of Westinghouse Electric Corporation, Bloomfield, N. J.

The Precious Metal Plating Award was donated by Technic, Inc., Providence, R. I. This is the award won by Edwin C. Rinker of Bart-Messing Corporation, Belleville, N. J.

The AES Bronze Medal Award was donated by the Grand Rapids branch. This award was won by Stanley L. Eisler, Jodie Doss, and Mary Ann Henderson of the Rock Island Arsenal, Rock Island, Ill.

The American Electroplaters' Society is grateful to the donors of these annual paper awards and here apologizes for the omission of their names.

Reference Publications on Electroplating

Listed below are books, journals, and miscellaneous publications that are primarily concerned with electroplating or that are likely to be of interest to people in the field of electroplating. This list is not intended to be complete or exhaustive, but it is intended to include the more commonly used references. Some of the books listed are out of print, but they should be available in libraries. The list was compiled by the National Bureau of Standards and was furnished PLATING by Fielding Ogburn, assistant chief of the electrodeposition section, division of chemistry.

Books:

ASTM Standards, 1952; Part 2, Nonferrous Metals. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

American Standard Safety Code for Ventilation and Operation of Open Surface Tanks. Publication No. Z9.1-1951. American Standards, Inc., 70 E. 45th St., New York 17, N. Y.

Corrosion Handbook, H. H. Uhlig, ed. John Wiley and Sons, Inc., New York (1948).

Electroplating, S. Field and A. D. Weill, 6th ed. Pitman Publishing Corp., London (1951).

Electroplating, A. H. Sanders. International Textbook Co., Scranton, Pa. (1950).

Fundamentals of Electrochemistry and Electrodeposition, S. Glasstone. American Electroplaters' Soc., New York (1943).

Industrial Polishing of Metals, G. F. Weill. Iliffe and Sons, Ltd., London (1950).

Metal Finishing: Guidebook and Directory. Finishing Publications, Inc., 381 Broadway, Westwood, N. J. (1954).

Metallizing Nonconductors, S. Wein. Metal Industries Publishing Co., New York (1945).

Metals Handbook. American Society for Metals, Cleveland, Ohio (1948).

Methods for Treating Metal Finishing Wastes. Ohio River Valley Water Sanitation Commission, 414 Walnut St., Cincinnati 2, Ohio (1953).

Modern Electroplating, A. Gray, ed., 2nd ed. John Wiley and Sons, Inc., New York (1953).

Principles of Electroplating and Electroforming, W. Blum and G. B. Hogaboom, 3rd rev. ed. McGraw-Hill Book Co., New York (1949).

Specifications and Tests for Electrodeposited Metallic Coatings. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. (1953).

Foreign Language Books:

Chromage, technique et applications, Paul Morisset. Editions Marval, Paris (1952).

AES Research Reports:*

Adhesion of Electrodeposits, Parts I, II, and III, A. L. Ferguson and E. F. Stephan, No. 1 (1946). $0.60.

Adhesion of Electrodeposits, Part IV, A. L. Ferguson. No. 2 (1946). $0.40.

Analytical Methods for the Determination of Cyanides and Cyanates in Plating Wastes and in Effluents from Treatment Processes, B. F. Dodge, W. Zabban, E. J. Serfass, and R. B. Freeman. No. 19 (1952). $0.65.

Cleaning and Preparation of Metals for Electroplating, H. B. Linford and E. B. Saubestre. No. 18 (1951). $1.65.

Current and Metal Distribution in Electrodeposition, Parts I, II, and III,

*(Available from the American Electroplaters' Society, 445 Broad Street, Newark 2, N. J.)

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CUSTOM FORMULATED PLASTISOLS — PROTECTIVE COATINGS — TANK LININGS — PLASTIC PIPE AND TUBING

J. Kronsbein and associates. No. 24 (1953). $0.75.

Determination of Impurities in Electroplating Solutions, Parts I–VI, E. J. Serfass and W. S. Levine. No. 3 (1947). $0.50.

Determination of Impurities in Electroplating Solutions, Parts VII–XIV, E. J. Serfass and coworkers. No. 6 (1949). $1.25.

Determination of Impurities in Electroplating Solutions, Parts XV–XIX, E. J. Serfass and coworkers. No. 16 (1950). $1.00.

Disposal of Plating Room Wastes, B. F. Dodge and D. C. Reams, Jr. No. 9 (1948). $0.75.

Disposal of Plating Room Wastes, II, B. F. Dodge and D. C. Reams. No. 14 (1949). $1.00.

Disposal of Plating Room Wastes, III and IV, B. F. Dodge and W. Zabban. No. 22 (1953). $1.75.

Disposal of Plating Room Wastes, V and VI, C. A. Walker and W. Zabban. No. 25 (1954). $1.35.

Effect of Impurities and Purification of Electroplating Solutions, D. T. Ewing and W. D. Gordon. No. 15 (1950). $0.90.

Effect of Impurities and Purification of Electroplating Solutions. I: Nickel Solutions, Parts 3, 4, 5, and 6, D. T. Ewing and associates. No. 23 (1953). $1.25.

Physical Properties of Electrodeposited Metals, V. Zentner, A. Brenner, and C. W. Jennings. No. 20 (1952). $1.25.

Polarization and Overvoltage: Selected Bibliographical Abstracts, R. A. Schaefer and W. King. No. 21 (1952). $1.30.

Porosity of Electrodeposited Metals, IV–IX, N. Thon, Denis Kelemen, and Ling Yang. No. 17 (1950). $1.00.

Stripping of Copper from Various Base Metals, Parts I and II, F. C. Mathers, C. E. Landwerlen, and E. L. Martin. No. 4 (1947). $0.35.

Government Publications:

Electrodeposition Publications by the Staff of the National Bureau of Standards, LP-14. National Bureau of Standards, Washington 25, D. C.

Electroplating Job Shop. TAS 20.7, PB 99147. Office of Technical Services, Department of Commerce, Washington 25, D. C. $0.25.

Electroplating Processes. IR 6578. Office of Technical Services, Department of Commerce, Washington 25, D. C.

Periodicals:

J. Electrochemical Society (formerly *Transactions of the Electrochemical Society*). Electrochemical Society, Inc., 216 W. 102 St., New York 25, N. Y.

Metal Finishing. Finishing Publications, Inc., 381 Broadway, Westwood, N. J.

Plating (formerly *Monthly Review*). American Electroplaters' Society, 445 Broad St., Newark 2, N. J.

Proceedings. American Electroplaters' Society, 445 Broad St., Newark 2, N.J

Bulletin of the Institute of Metal Finishing. Institute of Metal Finishing, Great Ormond St., London, W.C.1., England.

Transactions of the Institute of Metal Finishing (formerly *Journal of the Electrodepositors' Technical Society*). Institute of Metal Finishing, 32 Great Ormond S., London, W.C.1., England.

OBITUARY

✣ **Williard J. Whitney**, 77, former owner of the Phoenix Plating and Manufacturing Company, Grand Rapids, Michigan, died at his home on 4 September 1954. Whitney was a charter and honorary lifetime member of the Grand Rapids branch of the American Electroplaters' Society, and he had served in several offices for the local branch.

Whitney had retired from his business in 1950.

He was a lifelong resident of Grand Rapids and a nephew of the founder of Whitneyville, a village 15 miles from Grand Rapids.

BRANCH SPEAKERS LIST
1954-1955

Addition to List Published in July
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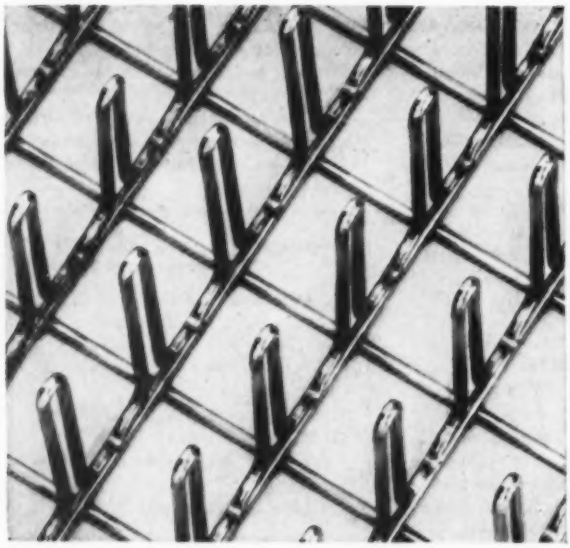
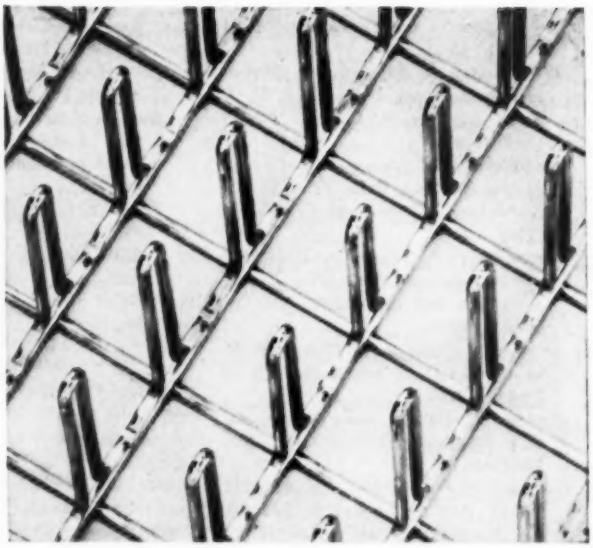


Photograph of dish drainer basket plated in ordinary chromium solution. Dark areas at base of wire fingers show no coverage of nickel.



Same product when plated in SRHS Chromium Solution. Note the even color at top and base of finger — evidence of complete coverage.

Making the most of Quality to cut your plating costs?

United Chromium points out ways to reduce expenses in the coating of metals

AT FIRST THOUGHT, "quality" seems to imply high cost. However, in a production operation like plating, quality doesn't have to cost more – it can *save*. Here are some specific cases showing how:

SAVE WITH HIGHER QUALITY CHROMIUM PLATING

It's easy to recognize a top grade chromium finish. It's bright, with no grey or rainbow plate, no burns or misses – and the deposit meets thickness specifications. The benefits of such quality plating are obvious: fewer rejects or costly reruns.

This is the kind of quality being obtained with Unichrome SRHS Chromium Plating Solutions. Having wider bright plate range than ordinary solutions, SRHS covers even difficult parts with a bright deposit. Higher speed of these solutions cuts plating time up to half for a specified thickness. Also, important constituents of the baths are self regulated to maintain optimum plating balance.

In hard plating operations, the leveling action of SRHS Chromium Solutions cuts grinding and polishing requirements, too – saving still more finishing time. In short, while turning out a quality job, SRHS also saves hours, work and headaches.

UNDERCOATS WITH QUALITY TO MATCH

Copper and Nickel plating not only contribute to the quality of the final chromium finish, but also affect the economy of the entire cycle of operation. Quality and economy are both benefited by a cycle of plating processes which are matched to each other.

Unichrome Bright Nickel, for instance, provides greater receptivity for the subsequent chromium. Passivity problems and activating treatments are avoided. Moreover, since this bath has proved exceptionally tolerant to impurities, it produces more flawless work with fewer purification treatments. Obviously, a process which can keep up a pace of untroubled production cuts operating expense.

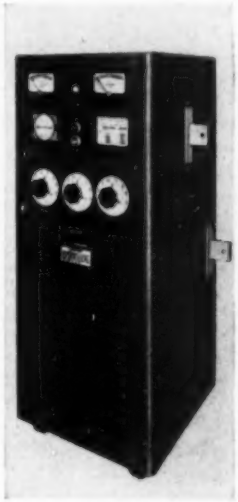
Unichrome Pyrophosphate Copper constitutes

the other member of this matched finishing cycle. It plates quality deposits of such smoothness that buffing of copper or subsequent nickel is minimized or eliminated. One plant was in this way able to cut out 98% of the need for buffing nickel, thereby saving 48 man-hours of buffing labor daily.

QUALITY EQUIPMENT COSTS LESS PER YEAR

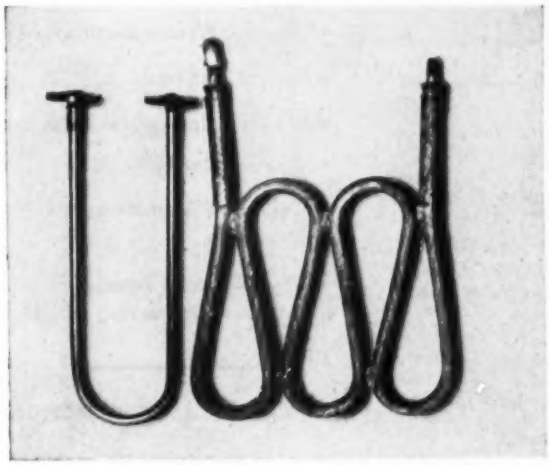
Production equipment plays a big part in production cost. The actual cost depends on how efficient the equipment is, how well it stands up, and how much time and effort it can save. In other words, it depends on quality.

Thus, Unichrome Rectifiers are built with the quality for money saving performance in plating and anodizing. They're unusual in stack design, transformer ratings, wiring, insulation details and other features – to give long, economical service at high efficiency.



Unichrome Rectifiers contain quality features that make them outstanding sources of low cost power for plating and anodizing. Shown here is a self-contained unit which includes the basic rectifier, meters, starter and controllers – all completely wired and ready for operation.

As another example, Unichrome Tantalum Coils and Heat Exchangers represent the finest equipment of their kind for use in acid plating solutions – chromium in particular. Because they are acidproof, they maintain heat transfer efficiency and can last indefinitely. At one plant, a Unichrome Tantalum Coil was inspected after four hard years of chromium plating service and found still like new. In another case, the coils' quality helped pay for the installation within months by eliminating downtime and production loss formerly experienced with lead coils.

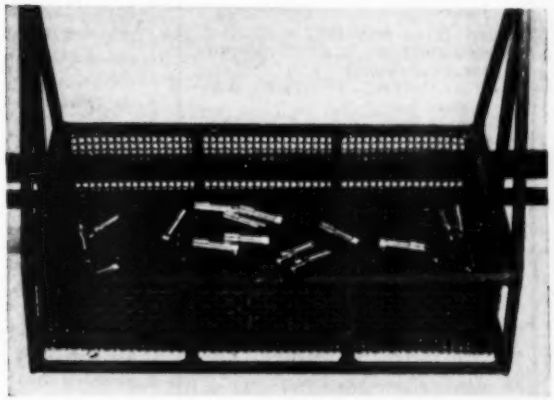


Simple, short hairpin Unichrome Tantalum Coil at left does better heating job in chromium plating bath than bulkier lead coil at right.

THE QUALITY RACK COATING

Racks represent some of the hardest working equipment in the plating shop. Coatings which have the quality to keep up with these "tools" without peeling, cracking or blistering can help reduce dragout losses, drag-in contamination, and rack maintenance expense.

Unichrome Coating 218X, a green plastisol compound and a familiar sight in many of the most cost-conscious plants, withstands all plating and cleaning cycles – even those including vapor degreasing. In some cases, the coatings have actually outlasted the racks themselves.



Quality of the familiar green Unichrome Coating 218X is so well known today that it is being used to save maintenance on equipment other than racks. Here is a dipping basket where Plastisol Coating 218X protects the work from scratches and withstands degreasing and cleaning cycles.

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1—5000/2500 AMPERE, 8/16 VOLT, **CHANDEYSSON,** 25° C., Exciter-in-head.
1—5000/2500 AMPERE, 6/12 VOLT, **CHANDEYSSON,** 25° C., Synchronous, Exciter-in-head.
1—4000/2000 AMPERE, 6/12 VOLT, **CHANDEYSSON,** 25° C., Exciter-in-head.
1—3000/1500 AMPERE, 6/12 VOLT, **ELECTRIC PRODUCTS,** Synchronous, Exciter-in-Head.
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1—2000/1000 AMPERE, 8/16 VOLT, **ELECTRIC PRODUCTS.**
1—1500/750 AMPERE, 6/12 VOLT, **HANSON-VAN WINKLE-MUNNING,** Synchronous, Exciter-in-head.
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1—1000 AMPERE, 30 VOLT, **IDEAL,** Exciter-in-head.
1—1000 AMPERE, 40 VOLT, **CHANDEYSSON,** 25° C.
1—750 AMPERE, 60 VOLT, **HANSON-VAN WINKLE-MUNNING,** Synchronous, Exciter-in-head.
1—500 AMPERE, 25 VOLT, **CHANDEYSSON,** Synchronous, Exciter-in-head.
1—400 AMPERE, 40 VOLT, **M. G. C.,** Exciter-in-head.

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Branch News

BUFFALO

The first annual educational session of the Buffalo branch will be held on 2 October 1954 at the Markeen Hotel.

At 1:00 P.M. the following papers will be presented in the Sanford White Room:

"Periodic Reverse Copper Plating," by **Myron Ceresa,** Westinghouse Electric Corporation.

"A Method for the Evaluation of Cutting Power of Various Tumbling Media," by **H. A. Fudeman,** Trico Products Corporation.

"Barrel Plating," by **B. G. Daw** Lasalco, Inc.

A social afternoon for the ladies has been planned while the men are attending the educational session.

A gala banquet will be held starting at 7:00 P.M. featuring the finest in food and the finest in music.

For reservations please contact the chairman, **Robert F. Hofmann,** at 16 Ward Park Road, Grand Island, N. Y.

CENTRAL MICHIGAN

The board of directors of the newly named Central Michigan branch were imprisoned recently in the Lansing jail, but not for long and not for any heinous crimes. The whole thing was planned by the branch president, **Fred W. Stuckenberg.**

"I've been a special deputy sheriff for several years, and as a little novelty I thought the boys would enjoy a tour through the establishment," said Stuckenberg, whose regular job is with the Carrier-Stephens Company. "The stunt certainly guaranteed a sober meeting, for one thing."

Stripped of the striped prison garb, board members took action on several items of business. They changed the branch name from Jackson-Lansing to Central Michigan, and they decided to incorporate the branch under the laws of the state of Michigan.

"We changed the name because many of our members are from cities in central Michigan other than Jackson and Lansing, and it makes our branch more readily identifiable to other members throughout the society," Stuckenberg said.

INDIANAPOLIS

The first meeting of 1954–1955 was attended by 24 members on 8 September at Fox Steak House. **George Taylor** of Adele, Georgia, a member of the Atlanta branch, was a guest at this meeting. The minutes of the May meeting were read and approved. **Carl Niehaus,** treasurer, gave a detailed report. Final figures of the dinner-dance were given and a profit of $110.53 was made.

Tom Evans gave an outline of the 4 October meeting, which will be at

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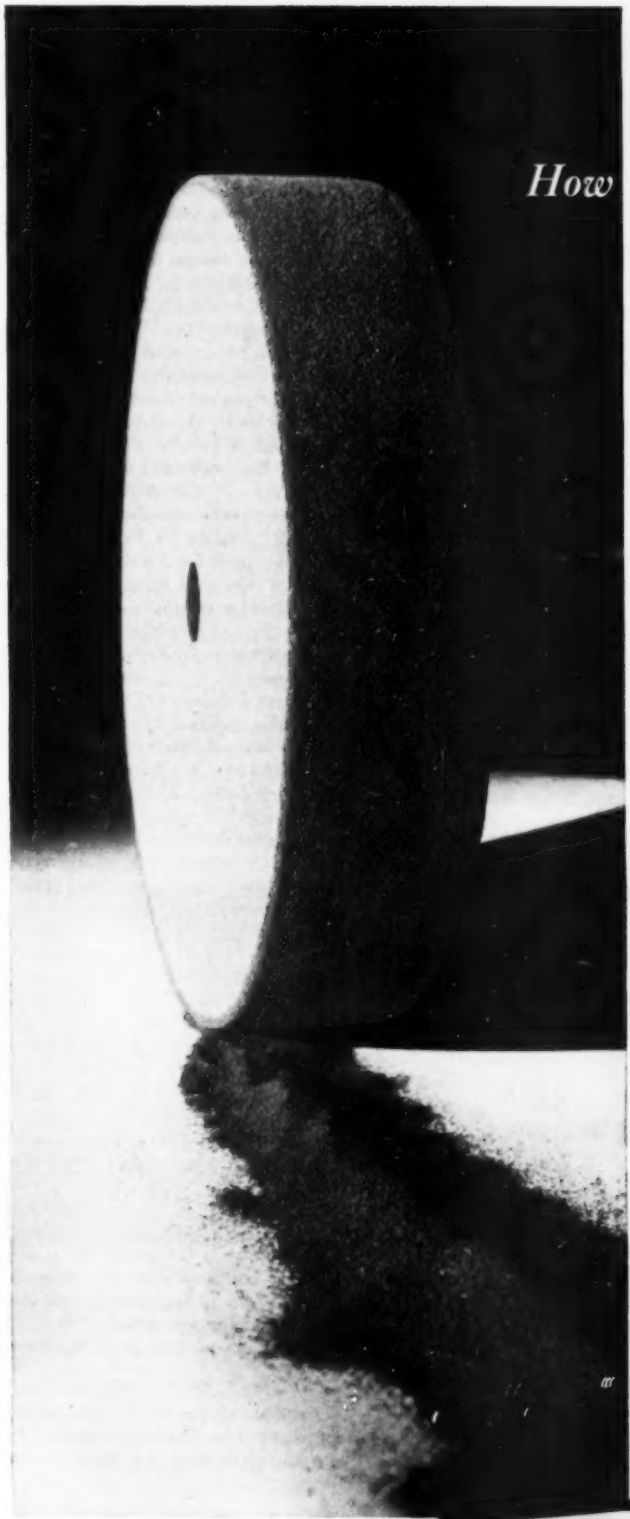

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When setting up your metal polishing wheels or belts, remember these advantages of Norton ALUNDUM abrasive grain:

- It is extremely hard, tough and sharp.
- It is uniform in chemical composition, crystal structure and grain size — no oversize grains to mar the surface, no undersize grains to loaf on the job.
- Its high capillarity, produced by special Norton processing, means easier wetting with the glue and assures stronger, faster cutting, longer lasting wheel heads.
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Watch your setting up temperatures!

Cold wheels and cold abrasive grain jell the hot glue too rapidly, which reduces its adhesiveness and prevents sufficient pickup of grain, resulting in slow cutting, hot running wheel heads. To guard against this, pre-heat wheels and grain to between 100° and 120°F, so the glue solution can be applied at a temperature of 140°F. Also, hold the setting up room temperature around 80°F, use uniform pressure when rolling wheels in the grain trough, and make the whole procedure as fast as possible.

Further helpful information

on every factor in the setting up process — including the selection of ALUNDUM grain, preparation of glue, use of cement, drying operations, wheel types, polishing different metals, etc. — is contained in the Norton booklet *Setting Up Metal Polishing Wheels and Belts.* Your Norton Distributor can supply it, and can make quick deliveries of ALUNDUM grain from complete stocks in key cities. Or write to NORTON COMPANY, Worcester 6, Mass. Distributors in all principal cities, listed under "Grinding Wheels" in your classified phone directory. *Export:* Norton Behr-Manning Overseas Incorporated, Worcester 6, Massachusetts. G-275

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*These prices are approximate. They vary with market conditions but since both are dependent upon the price of the base metals of which they are made, the relation between them remains much the same.

Photo courtesy U. S. Metals Coatings Co., Inc., Elizabeth, N. J.

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Branch News

Columbus at the Arvin Cafeteria at 6:45 P.M. The program will be a surprise.

Discussion followed as to how to increase the attendance at regular meetings. **Herb Kennedy,** first vice-president, is charged with this problem.

The branch was notified by **Ed Bruck** that an invitation to hold the interim meeting in Indianapolis was extended to the AES at the New York convention. This has to be accepted by the national officers at their coming meeting.

Plans for the next annual dinner-dance are being made. **Quentin Shockley** is the general chairman. By a motion by **William Niehaus** and seconded by **Les Reynolds,** an educational session will precede the dance. On a motion by Kennedy and seconded by Evans there will be just one price for the tickets.

A letter was read from the Columbus branch about a meeting on 8 October to plan for the next tristate regional. Our representative to this meeting will be selected soon.

One new member was voted into the branch on a motion by Kennedy and seconded by **Robert Bruck.** He was **Albert K. Miegl,** 904 N. Kelsey, Evansville, Ind. Miegl is with Electronics Research at Evansville.

At a called meeting of the officers and board of managers on 27 May a new member was voted into the branch. Shockley moved that the decision made at this meeting be approved and this was seconded by Bruck. The new member was **Lorlys R. Rogers,** P. O. Box No. 6, West Newton, Ind.

Robert VanHouten, librarian, gave an outline of the year's programs. There is a great variety of programs scheduled. Each month has been planned, and the branch should enjoy a good year.

The program for the evening was the paper that our branch will present to PLATING entitled "Some Aspects of Solution Level Control." **John Holland** and his committee have worked diligently on this subject. The paper was read in part, and much interest and discussion followed. It is to be corrected and completed by the October meeting.

EDNA ROHRABAUGH, *Secretary*

JACKSON-LANSING

The name of the branch has recently been changed to Central Michigan. For news of this branch, see under Central Michigan.

MELBOURNE

The regular monthly meeting was held at the Melbourne Technical College on 19 August, with **P. Tikotin** as chairman and 34 members present. Two short films were shown before the meeting began.

Mr. **Teague** introduced the speaker

for the technical session, **T. W. Brown,** a branch member. Brown's lecture was entitled "Electroplating in Lithographic Printing."

The speaker pointed out the difference between lithographic printing and other methods. The development of the various types of lithographic printing were described. Many patents have been taken out, but only relatively few methods have survived. Formerly the high cost of production of the plates prevented its widespread use, but this cost is not as large a factor with present day high production machines.

Slides were shown illustrating how the various types of plates are produced.

When moving a vote of thanks to the speaker, **H. Littauer** stated that although this use of electroplating has little or no eye-appeal, as compared with bright plated details, it was nevertheless a very specialized field. The vote was carried by acclamation.

NEW HAVEN

A business meeting was held on 8 June 1954 at Fitzgerald's Restaurant to make plans for the coming year. President **Edward Busby** asked for a roll call of the elected officers for 1954–1955:

President.....**Edward F. Busby**
Vice-President...**William K. Murray**
Secretary-Treasurer **Bernard Gaffney**
Librarian.....**Austin P. Jackson**
Assistant Librarian.....**Leo Roberti**
Sergeant at Arms.....**John J. Odoy**

After Secretary **Bernard Gaffney** read the correspondence, President Busby appointed his committees and asked for discussion on the various phases of his program.

A committee headed by Dr. **Kellner** is to investigate the possibilities of securing a suitable meeting place for the coming year. Yale facilities such as the Sterling, Dunham, and Osborne laboratories were suggested.

The education committee, headed by Librarian **Austin Jackson**, was offered a group of 15 subjects from which to select a program that will interest the majority of the chapter membership.

The entertainment committee, headed by **John Barry,** will make the necessary preparations for a Christmas party for 3 or 4 December. John Barry will also head the sick committee.

William Murray, as head of the research committee, will try to get new sustaining members. He will need the full cooperation of the entire membership to sell the AES research program to prospective subscribers. He will also head the planning committee for the next New England regional.

The membership committee will be headed by **Harry Taylor.** It was suggested in the discussion that emphasis be placed on the reactivation of old members. A person-to-person campaign is most likely to bring results, and Harry promises action along these lines.

The membership unanimously voted honorary memberships to **Al Rosenthal** and **Joe Cooke.**

PITTSBURGH

Through arrangements made by the Pittsburgh branch president, **R. E. Varner,** Weirton Steel Corporation has arranged a tour of their tin mill facilities for the branch's meeting on 6 October.

In addition to the tour, a dinner will be given by Weirton Steel Corporation for the Pittsburgh branch at the new Community Center in Weirton, W. Va. The tour will begin at 2:30 P.M., and dinner will be at 6 P.M.

A regular meeting will follow the dinner. The speaker will be **John A. Swift,** president of Swift Industrial Chemical Company, who will talk on "Manufacture, Rolling, and Cold Working of Steel and How These Factors May Affect Plating."

Weirton Steel has one of the largest and most modern electrolytic tin plate mills in the country. Their high speed plating units for the continuous plating of strip steel use the halogen tin process. This tour will afford many members an opportunity to see steel processing and plating on a gigantic scale and at tremendous speed.

The Pittsburgh branch held its first regular meeting of the fall on Wednesday 1 September 1954.

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Before we developed the Patwin C-1 Electro-Polarizer, we spent an average of 60 minutes in analyzing a typical solution by chemical methods. Now, with this instrument, analyses of very high accuracy are completed in 15-20 minutes! Our production has been speeded considerably, and we want to pass the news along to other electro-platers facing the same problem.

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New Step-by-Step Manual

We've gone one step further. Our new 65-page manual (just off the press) tells the plater—step by step—how to use the C-1 Electro-Polarizer to find the exact content of his plating solutions—in *Minutes!* It also has alignment charts for 19 common solutions which reduce computations to slide-rule simplicity.

The Patent Button Company

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Members of the branch were pleased to welcome a new member into the branch, **Alexander Hays, III,** and to be hosts to two guests from National Electric Company.

R. J. Goldbach, in behalf of the branch, presented a pipe and tobacco to Mr. **Ryan** of the Sheraton Hotel in appreciation of all he has done for the members in providing a meeting room and in arranging dinners.

The speaker was **Arthur H. DuRose,** manager of electroplating development for the Harshaw Chemical Company. His subject was "Electroplating—Art or Science?" The main point of DuRose's talk was the poor reproducibility in electroplating work due to the individual artistic touch involved in doing the work.

Librarian **Fred Dixon** presided over a lively discussion period on nickel plating and salt spray testing.

As an added attraction this year, a door prize is being given away at each meeting through the courtesy of the suppliers. **Bill Musmanno** was the lucky member, winning a Universal automatic coffee maker presented by Harshaw Chemical Company.

SAN ANTONIO

A. M. Linn of United Chromium, Inc., presented a comprehensive paper on "Self Regulating High Speed Chromium Plating Baths" at the regular meeting on 16 August at the Belgium Inn. Interest in the subject was shown by the hour-long question and answer session after the meeting was adjourned.

President **Roy Rogers** reviewed the progress that the branch has made since its formation and called for progress reports from the various committee chairmen and the board chairman.

SOUTHEASTERN

On Saturday 14 August 1954 the Southeastern branch held its annual ladies' night at the Druid Hills Golf Club. This was attended by 45 members and guests.

After a steak supper, a drawing was held for door prizes donated by the following suppliers: **Ralph B. Goodson, Sr.,** Detrex Corporation, two electric percolators; **Charles Anger,** Parker Rustproof, a traveler's clock; **C. H. Hohner,** Udylite Corporation, a compact; and **Al Butterer,** MacDermid Corporation, an atomizer.

After the drawing there was dancing to the music of Charlie Spivak and his orchestra.

TORONTO

The first meeting of the 1954–1955 season was held at the Royal York Hotel on Friday 10 September. Last year's president, **B. Cameron,** formally turned over his office to the incoming president, **G. C. McDonald.** Benny Cameron was

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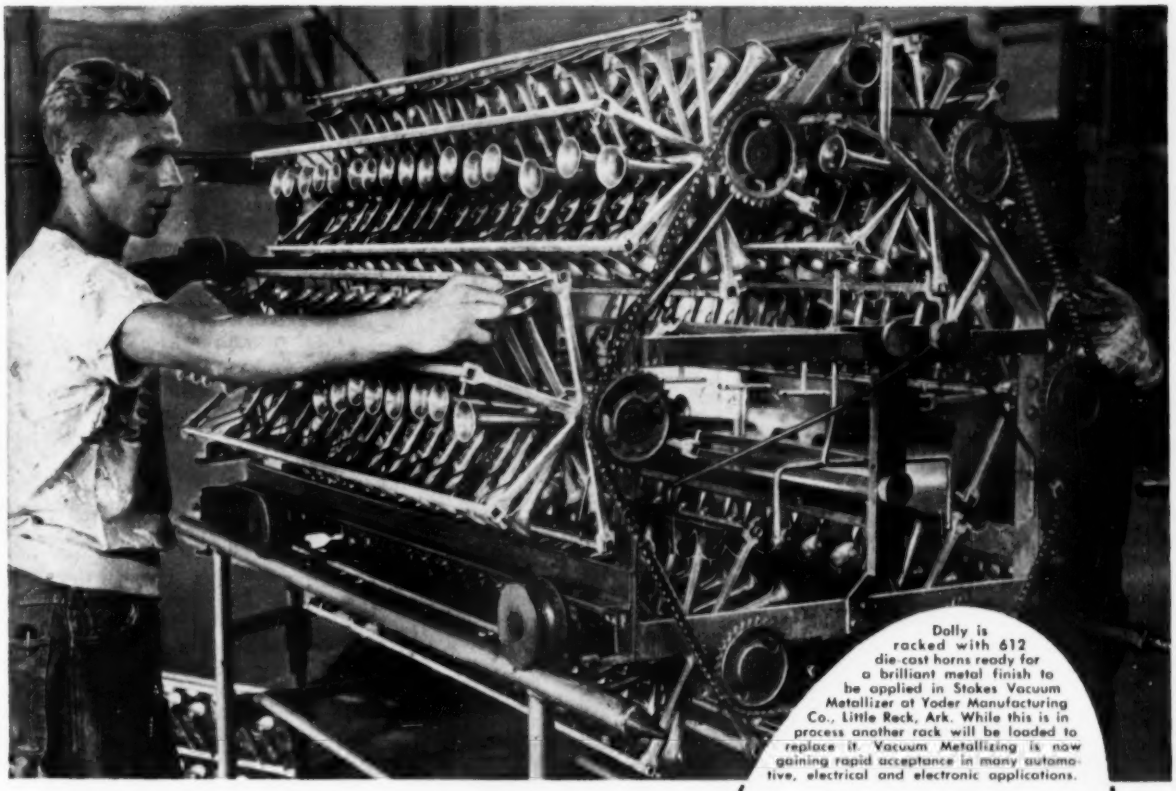

Dolly is racked with 612 die-cast horns ready for a brilliant metal finish to be applied in Stokes Vacuum Metallizer at Yoder Manufacturing Co., Little Rock, Ark. While this is in process another rack will be loaded to replace it. Vacuum Metallizing is now gaining rapid acceptance in many automotive, electrical and electronic applications.

In Minutes...Vacuum Metallizing will Metal-coat these 612 Die-cast Horns

Metallic finishes in many metals and many colors are now applied by Vacuum Metallizing and the product is ready for lacquering and packaging without hand work. No plating or finishing plant can afford to ignore the tremendous opportunities which Vacuum Metallizing creates.

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Stokes Laboratory will metallize your samples, evaluate your application, recommend techniques to be employed, plan cycles, report on costs . . . and share with you the benefits of Stokes' 40 years of leadership in high-vacuum technology.

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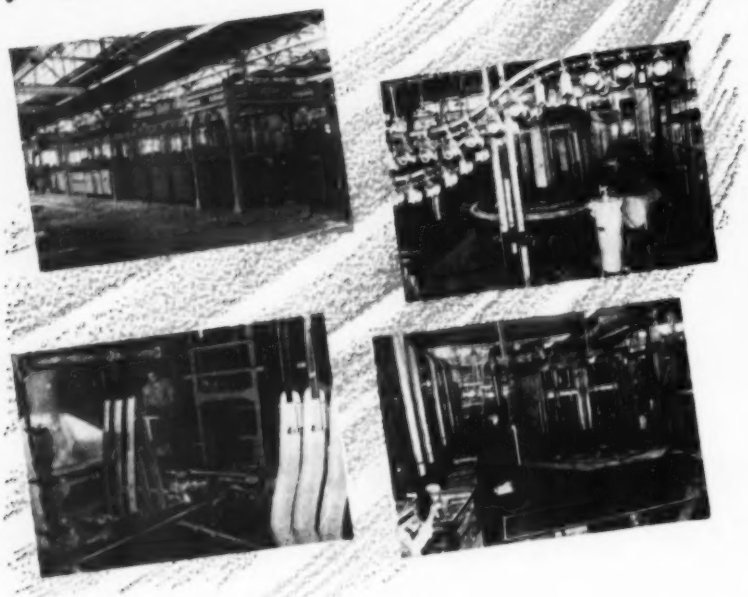

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Branch News

given a rousing vote of thanks for the excellent job he did last year.

John McRoberts, delegate to the 1954 AES Convention, gave a well-written and humorous report on the convention activities.

Coming events discussed were a fishing trip the week-end of 25 September and the Toronto branch annual dance planned for 18 November. Both events promise to be well worth attending.

Bert Granik, chief metallurgist for General Motors Corporation, Oshawa Division, introduced the speaker, **C. F. Nixon,** head of the electrochemistry department, General Motors Corporation research laboratories.

Nixon gave an illustrated talk on "Decorative Plating on Automobiles." He reported that automotive companies put a minimum of 0.0015 inch combined thickness of copper, nickel, and chromium on bumpers and grills and were now doing research on other factors affecting the corrosion of plate on automobiles rather than attempting to increase the plate thickness. There are also several AES research projects working on this subject, including Project No. 14 sponsored by the Toronto branch and the Ontario Government on the effect of the basis metal surface on corrosion.

Inspection data gathered from all over the United States and Canada since 1937 showed that (1) there was little difference in the corrosion plate rates on different makes of cars; (2) the plate is much better now than during the late thirties, despite the increase in the use of salt in roads and the recent shortage of nickel; and (3) the industrial areas and the provinces in the eastern sea coast had the highest rate of corrosion. Winter conditions in Detroit are extremely hard on plate.

A lively question period followed the talk, after which the meeting was closed.

J. G. SMITH,
Branch Correspondent

WESTERN ONTARIO

The Western Ontario branch held its May meeting at the William Pitt Hotel, Chatham, Ontario.

Dick Davidson, of the Grav-i-flo Corporation spoke on "Tumble Finishing." He pointed out that the proper compounds should be used with the proper chip and alloy. The best load level to use can be determined only by experience or actual tests on the parts. When satisfactory results are obtained, a record should be made so that when these parts are to be processed again all factors will remain the same. No one media will produce satisfactory finishes on all alloys. They must be selected in accordance with hardness to obtain the finish required.

J. H. VOLLANS, *Secretary-Treasurer*

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MICCROSTOP . . is designed to achieve an accurate line of demarcation in all plating cycles. It will go through cleaners and hot solutions without losing its exceptional adhesion, unsurpassed on sharp edges. The finest all purpose stop-off lacquer on the market today.

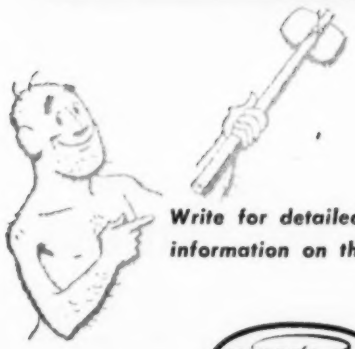
MICCROMASK . . is specifically designed for maximum adhesion in hard chrome plating. It will hold to a fine line and may be easily removed after plating. Dries rapidly. Multiple coats will take any long cycle without treeing.

Note: Both MICCROSTOP and MICCROMASK may be removed easily in MICCROSTRIP A.

MICCROWAX . . . C-562 is the outstanding product for the most efficient method of selective hard chrome plating. Melting at 180°F, it is especially applicable for flat surfaces and sharp edges, where dipping is feasible.

. . . C-600 will take all plating cycles without losing adhesion. Melting at 300°F, it is not affected by temperatures, acids, or caustics used in any plating operation.

Both MICCROWAX C-562 and C-600 may be reused. Only one dip tank is required. Both harden immediately, cutting down application time to a minimum.



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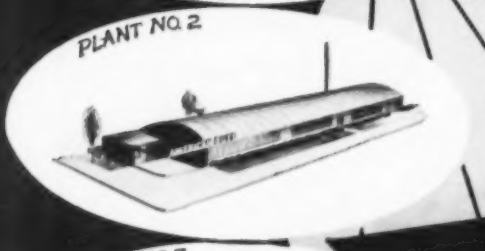

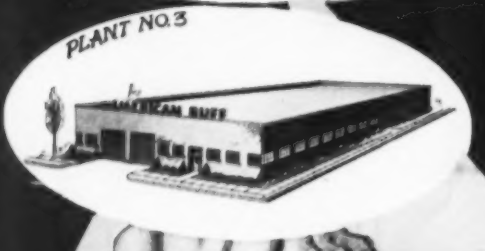

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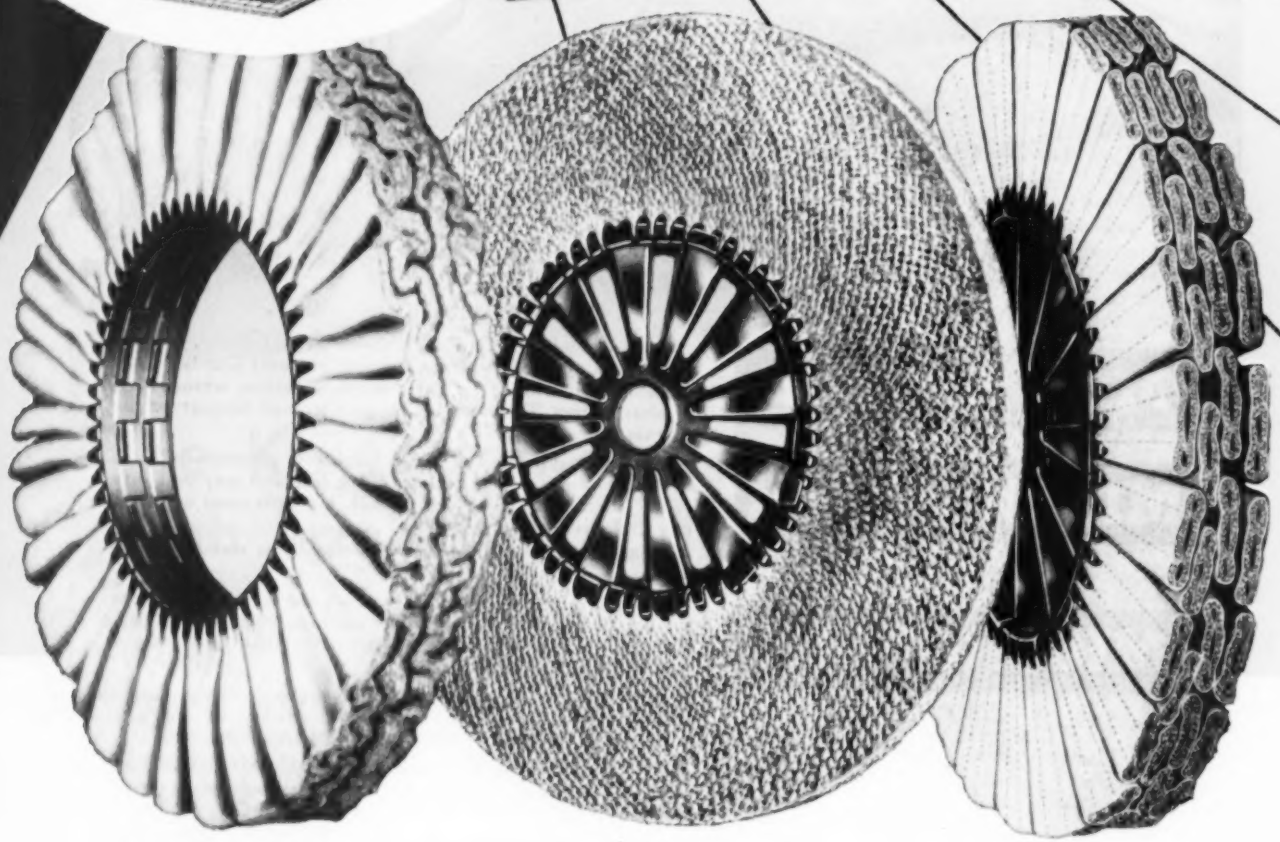

Automatic BIAS BUFF

This versatile buff does both cutting *and* coloring on a wide variety of metals. Like other American "Automatic" buffs, it features the patented *Centerless* construction with exclusive "Pre-Assembly". Also available with permanent steel or fiberboard centers.

Automatic BIAS SISAL BUFF

Top-quality *all-new* sisal gives this buff unmatched durability and fast cutting. Exclusive "permanizing" process actually *locks fibres together* . . . eliminates scratching and fraying. Available in Centerless model or with Permanent Center.

Automatic UNIT SISAL BUFF

Extra-flexible for fast cutting and finishing on contoured surfaces. Sisal "units", cloth wrapped to prolong wear, follow every crevice and variation in shape. Air-cooled *unit design* prevents burning or discoloration, even at high speeds. In Centerless or Permanent Center types.

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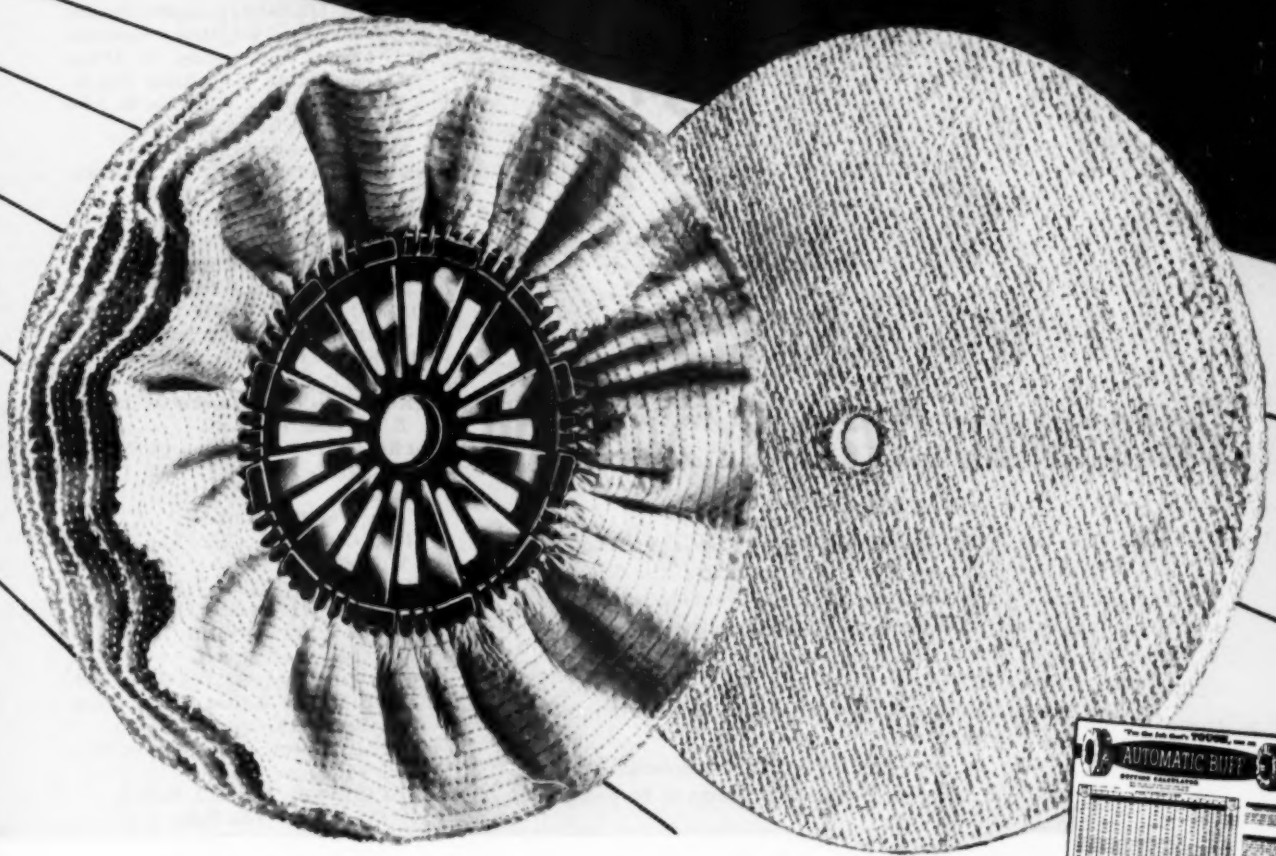

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Instantly tells you the right buff . . . right size . . . right speed for every job! Write for yours today!

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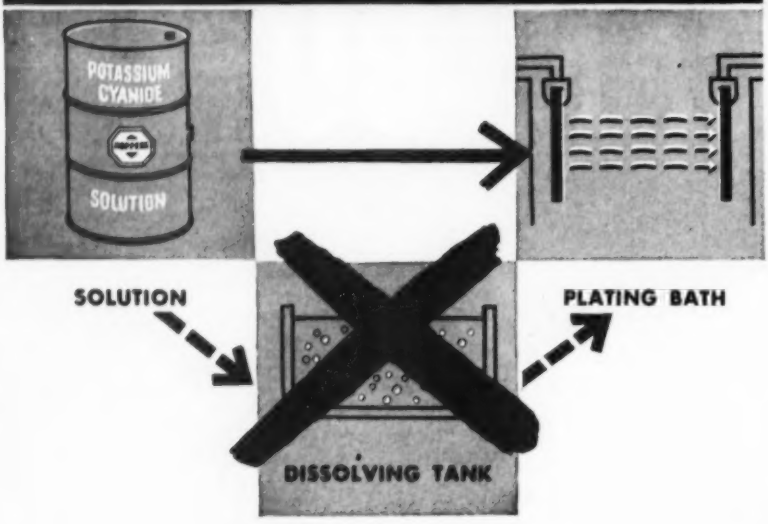

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HOUSTON: P. A. Finn, from Dallas-Ft. Worth; P. J. Nicks, to Dallas-Ft. Worth
PROVIDENCE-ATTLEBORO: Dr. C. B. F. Young, to Newark
SPRINGFIELD: J. C. Kosmos, to Newark
SYRACUSE: Frank X. Leone, to Capitol District

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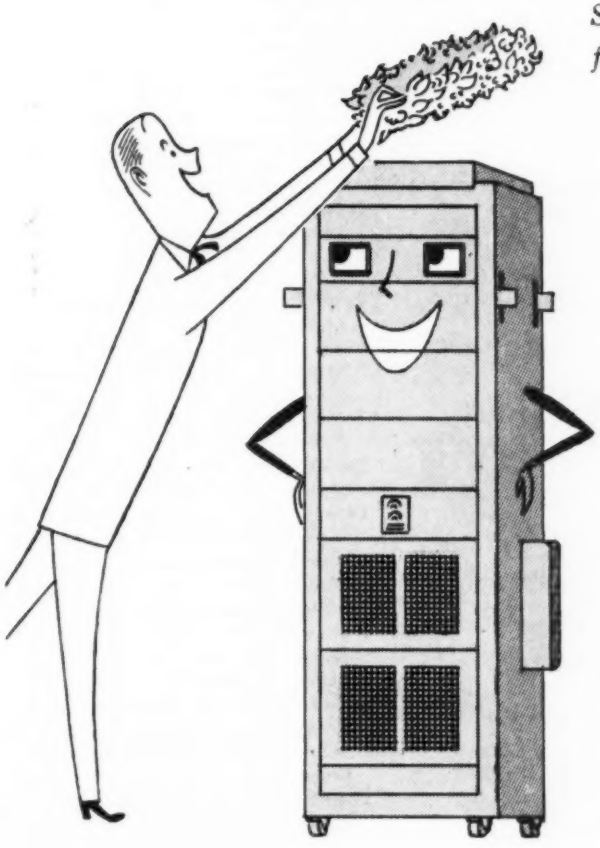

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Eaton Manufacturing Company
Cleveland, Ohio (Clev)
Ekco Products Company
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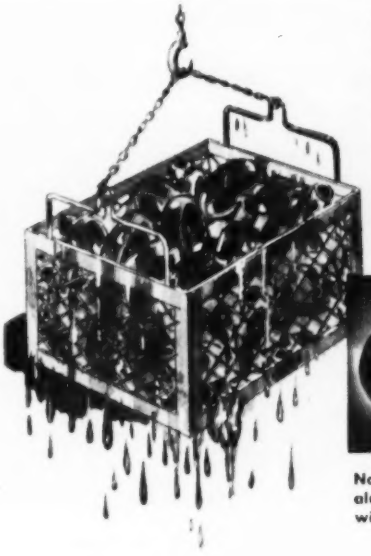

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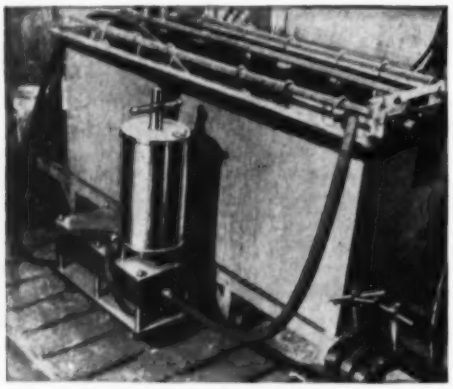
get better finished plated work — save time and labor



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DIS-STRESSED* Plating Cylinders

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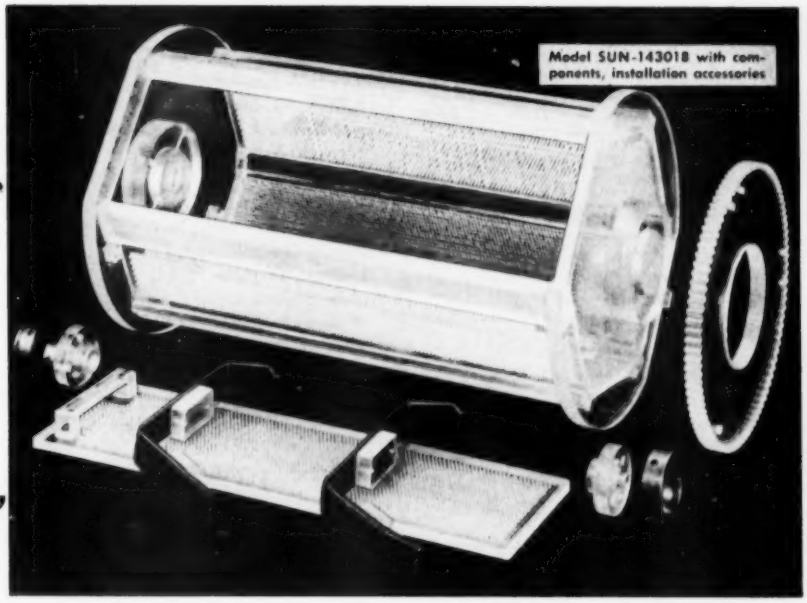

Avoid Distress with Singleton "H-T Sincolite" Dis-Stressed Cylinders

Here's inside dope on internal stresses

I NEVER FORGET! The "Flat" Shape Stays

"Plexiglas has a peculiar property called **'elastic' or 'plastic' memory,"** says Rohm & Haas Bulletin 4b, "If a flat sheet is bent . . . when heated, it will retain the new shape as long as it is kept **below 180° F.!** Dupont says, "Lucite has the property of **'elastic memory,'** when a formed piece is heated beyond the softening point . . . the plastic tends to **return to the shape it was initially cast."**

No Dangerous Curves

Don't gamble on "formed shapes"! Tough, rugged Singleton "H-T Sincolite" Cylinders are **fusion-welded, heavy-ribbed, flat panel construction throughout.** They set the "pattern" for the industry—recently adopted by one of the largest makers. **Not bent or formed in any way**—so not limited in high temperature applications as are formed cylinders.

Engineered . . . "Opinioneered"

Good **engineering** wasn't enough. These cylinders have been **"opinioneered"** by some of the best platers in the world (and some of the worst). Nearly **everybody** got into the act, so these cylinders have got **everything.** They're the **only** cylinders platers swear **by**—not **at!** There's a model to fit any make superstructure.

Be a "Professional Opinioneer"!

Let us hear from you. We'll send complete literature, we'll quote prices. And, you'll receive your "official" card identifying you as a (big shot) "Professional Opinioneer." Write or phone.

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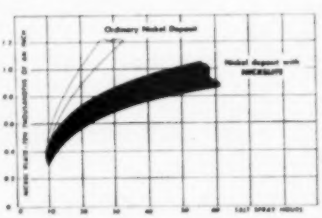
cuts your barrel nickel brightening costs

Concentrated to quadruple-strength—you don't ship, store or handle water. Shipped in quart bottles, four to a carton—shipping weight is cut 275%. No container deposits—no carboys to return. Use direct from the bottle, or dilute three-to-one. One bottlecap full of concentrate holds 8 to 10 cc.—enough for a barrel load of bright nickel.

Stable at high solution temperatures, you turn out a better, brighter plate in a shorter time. Not filtered out in normal processing—your replenishments are kept low. Gives you a more ductile plate by eliminating the usual brittleness of barrel nickel finishes.

for greater corrosion resistance

Nickelite boosts corrosion resistance of barrel plated nickel on steel 30 to 100% by standard 20% salt fog tests. With 0.00006 inch of ordinary nickel deposit, you can expect 11-13 hours of exposure before corrosion—Nickelite added gives you from 13-22 hours. Thicker coatings show even greater improvement.



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A barrel load of bright nickel . . .
WITH A NICKEL'S WORTH OF NICKELITE

ASTM-AES SPECIFICATIONS FOR PLATED COATINGS

All numerical requirements refer to minima on significant surfaces.

Zinc on Steel: A164

Coating	Type G.S.	Type L.S.	Type R.S.
Zinc, inch	0.001	0.0005	0.00015

Cadmium on Steel: A165

Coating	Type N.S.	Type O.S.	Type T.S.
Cadmium, inch	0.0005	0.0003	0.00015

Nickel-Chromium on Steels: A166

Coating	Type D.S.	Type F.S.	Type K.S.	Type Q.S.
Copper plus nickel, inch	0.0020[a]	0.0012	0.00075	0.0004
Final nickel, inch	0.0010	0.0006	0.0004	0.0002
Chromium (if required), inch	0.00001	0.00001	0.00001	0.00001
Resistance to standard salt spray, hours without appreciable corrosion	96	72	48	16

[a]The use of an extremely thin copper strike may cause operational difficulties such as corrosion of the basis metal during transfer of parts.

Nickel-Chromium on Copper and Copper-Base Alloys: B141

Coating	Type F.C.	Type K.C.	Type Q.C.
Nickel, inch	0.0005	0.0003	0.0001
Chromium (if required), inch	0.00001[a]	0.00001	0.00001

[a]Maximum thickness of chromium should be kept below 0.00005 inch to prevent cracking of nickel deposits on brass

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Requests will be forwarded to the manufacturer

Nickel-Chromium on Zinc and Zinc-Base Alloys: B142

Coating	Type F.Z.	Type K.Z.	Type Q.Z.
Copper plus nickel, inch	0.0012	0.00075	0.0005[a]
Copper, inch	0.0002	0.0002	0.0002
Final nickel, inch	0.0005	0.0003	0.0003
Chromium (if required), inch	0.00001	0.00001	0.00001
Resistance to standard salt spray, hours without appreciable corrosion	48	32	16

[a]"Total" of 0.0003 inch if alternative of nickel only is used.

Lead Coatings on Steel: B200

Type	Copper inch	Lead inch	Salt spray Resistance[a] hours
E.S.	.....	0.0010	96
E.E.S.	0.000015	0.0010	96
M.S.	.....	0.0005	48
M.M.S.	0.000015	0.0005	48
P.S.	.....	0.00025	24
P.P.S.	0.000015	0.00025	24

[a]To standard salt spray test in hours without appreciable corrosion.

Chromate Finishes on Zinc: B201

Parts shall show no white corrosion visible to the unaided eye at normal reading distance after 24 hours in a standard salt spray test. Before being tested specimens shall have been aged at room temperature for at least 24 hours after chromate treatment.

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Dear Fellow AES Member:

These questions are good ones, and you're entitled to ask them, particularly now that *you* and every other member *are investing* in our vital Research Program. Briefly, here are the basic answers:

$1—is each **regular member's annual payment** with the new per capita tax increase. This will provide the fund with over $6,000 each year. While the money is needed to help support an active, expanding program, it is perhaps equally as important in bringing you into the picture personally, to develop your interest and prompt you to **learn more about the program,** thereby obtaining your **full support** of it.

$100—is the annual cost of a **Sustaining Membership.** We currently have over 350 of them, held by about 300 firms. More are needed. All job shops and manufacturers should be vitally interested in strengthening and building the Electroplating Industry.

$40,000—is the approximate annual budget for the program. Realize that because AES Research is being carried out with much time devoted by members and member firms, and with most work done in college and university labs, that equivalent effort in industry would be up to *five times as costly!*

WATCH—this page for information on AES Research.

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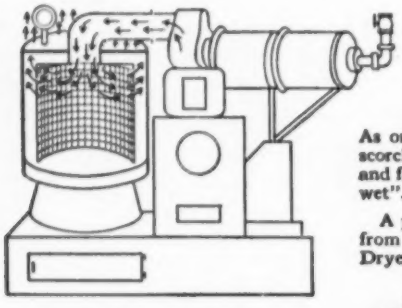
EVER BLOW INTO AN ASH TRAY?



If you did, you saw a practical demonstration of the principle of air deflection. In old type dryers, air *blown* in from the top is deflected by the top layer of parts. As one user put it, "the top layer gets scorched, the next layer is nice and dry, and from there on down the parts are still wet".

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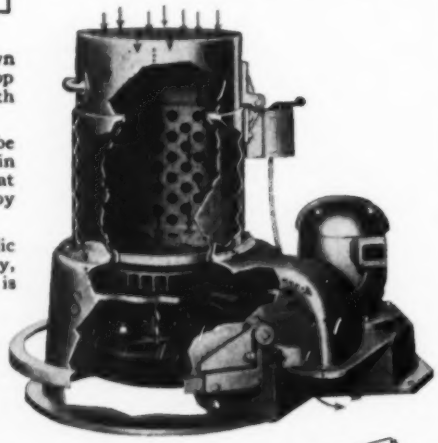
Steam or electric heaters may be mounted compactly in the cover in contrast with space consuming, heat wasting, separate units connected by pipe.

An internal expanding, hydraulic brake stops the machine smoothly, and quickly. The "brake pedal" is a ring extending around the entire working area so that the machine can be stopped instantly from any working position. In the interest of faster drying and lower costs write today!



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- **SUPERIOR** Anode Corrosion, making maximum use of plating metal.
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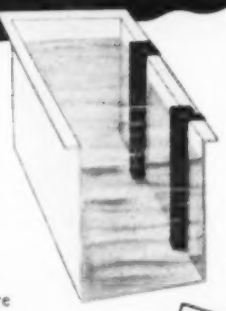
Heat by far Infra-Red. The scientific application of heat to all plating, pickling and phosphatizing solutions.



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No other coating for electroplating racks can match **chem-o-sol,** a plastisol formulation. Consider these benefits:

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CHICAGO meets second Friday of each month at 6 P.M. at Western Society of Engineers, 84 E. Randolph Street. Secretary-treasurer, Paul Glab, 882 N. Paulina Street, Chicago 22, Ill. Research finance committee chairman, Charles Geldzahler, c/o Platers' Technical Service, Inc., 509 S. Wabash Avenue, Chicago 9, Ill.

CINCINNATI meets fourth Wednesday of each month at 7:30 P.M. in Engineering Society Headquarters, McMillan Street and Woodburn Avenue. Secretary, L. J. Howald, 6265 W. Iehe Road, Cincinnati 13, Ohio. Research finance committee chairman, C. R. Sorber, 2004 Connecticut Avenue, Cincinnati 24, Ohio.

CLEVELAND meets first Friday of each month in Hotel Carter at 8 P.M. Secretary-treasurer, A. J. Lupien, 4408 Carnegie Avenue, Cleveland 3, Ohio. Research finance committee chairman, to be appointed.

COLUMBUS meets first Friday of each month at 8 P.M. in Battelle Memorial Institute Auditorium. Secretary-treasurer, Michael Farr, 1735 Franklin Ave., Columbus 5, Ohio. Research finance committee chairman, to be appointed.

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DAYTON meets third Wednesday of each month in the Biltmore. Secretary, Richard M. Clinchens, 33 W. Market St., Germantown, Ohio. Research finance committee chairman, Richard F. Moore, 526 Aberdeen Ave., Apt. B, Dayton 9, Ohio.

DETROIT meets first Friday of each month in Hotel Statler. Secretary-treasurer, R. J. Racine, c/o Wyandotte Chemicals Corporation, Wyandotte, Mich. Research finance committee chairman, L. M. Morse, c/o Chrysler Corp., Detroit, Mich.

GRAND RAPIDS meets second Friday of each month at Fingers Restaurant at 7 P.M. for dinner; educational session at 8:15 P.M. Secretary, John Dykstra, 104 Celia, S. E., Grand Rapids, Mich.

HAMILTON meets third Thursday of each month in the Conference Room, West End Plant, Canadian Westinghouse Company, Ltd. Secretary, R. Burke, c/o Swift Devices, 14 George Street, Hamilton, Ontario, Canada.

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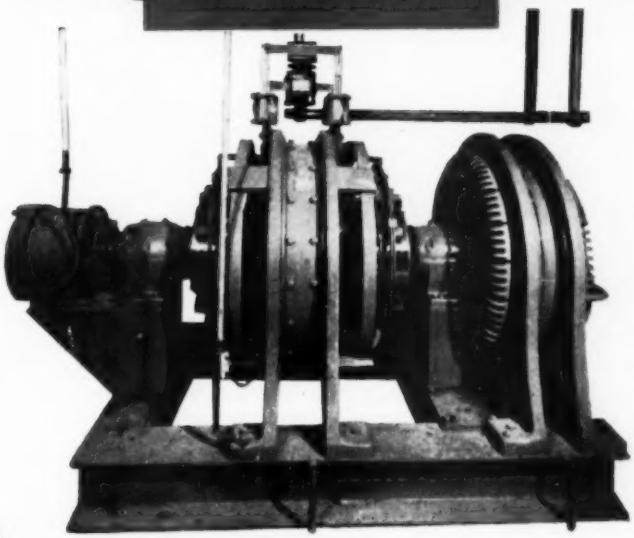

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HOUSTON meets third Tuesday of each month at 6:30 P.M. in the Ben Milam Hotel, Houston, Texas. Secretary-treasurer, H. L. Mauzy, P. O. Box 2119, Houston 1, Texas.

INDIANAPOLIS meets first Wednesday of each month at Fox Steak House, 1207 E. Washington Street. Secretary, Miss Edna Rohrabaugh, 816 Robert Street, Lafayette, Ind.

JACKSON-LANSING: Name has been changed. See Central Michigan.

KANSAS CITY meets fourth Thursday of each month at Roselli's Restaurant at 6:30 P.M. Secretary, Olin K. Bock, 5317 W. 58th Street, Mission, Kans.

LANCASTER meets second Friday of each month at 8 P.M. September, December, and April meetings are held at Hanover, York, and Harrisburg, respectively; all other meetings at the Old Mill Inn, Lancaster, Pa. Secretary-treasurer, Harry A. Saylor, 40 N. Poplar Street, Elizabethtown, Pa. Research finance committee chairman, Harry Hovis, Lincoln Highway, West Lancaster, Pa.

LOS ANGELES meets second Wednesday of each month at 6:30 P.M. in Rodger Young Auditorium. Secretary, Norman K. McEwan, 17222 S. Arlington, Ave., Torrance, California. Research finance committee chairman, Earl Coffin, 5102 Marburn Avenue, Los Angeles 43, Calif.

LOUISVILLE meets third Thursday of each month in Room 119, Speed Scientific Building, University of Louisville. Secretary-treasurer, Joseph G. Sterling, 1169 Keller Avenue, Louisville 13, Ky. Research finance committee chairman, T. K. Allison, 2502 Manchester Rd., Louisville 5, Ky.

MELBOURNE meets third Thursday of each month at 8 P.M. in Metallurgy Theatre, Melbourne Technical College, 124 Latrobe Street. Honorary secretary-treasurer, R. W. Lennie, 433 Clarke St., Northcote, Melbourne 16, Australia.

MILWAUKEE meets first Friday of each month in the East Room, Hotel Ambassador. Secretary-treasurer, Clifford A. Peters 1928 S. 29th St., Milwaukee 15, Wis. Research finance committee chairman, to be appointed.

MONTREAL meets first Tuesday of each month in Mount Royal Hotel. Secretary, Jean Monette, 11700 Notre Dame Street East, Montreal, Canada. Research finance committee chairman, P. M. Coady, c/o Alloycraft, Ltd., 27 Hillside Avenue, Westmount, Montreal 6, Canada.

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NEW HAVEN meets second Tuesday of each month alternating between Sterling Chemistry Laboratory, Yale University, and Hotel Taft. Secretary-treasurer, B. J. Gaffney, 40 Filbert Street, Hamden 14, Conn. Research finance committee chairman, Dr. H. L. Kellner, c/o Lea Manufacturing Company, 16 Cherry Avenue, Waterbury 86, Conn.

NEW YORK meets second and fourth Fridays of each month in the Statler Hotel. Secretary-treasurer, George Schore, 150 Bennett Avenue, New York 33, N. Y. Research finance committee chairman, Milton Nadel, 41-15 50th Avenue, Long Island City 4, N. Y.

PHILADELPHIA meets fourth Friday of each month. Meetings are held at the Broadwood Hotel, Franklin Institute, or the Engineers' Club. Secretary, I. William Marcovitch, 1302 St. Vincent Street, Philadelphia 11, Pa. Research finance committee chairman, to be appointed.

PITTSBURGH meets first Wednesday of each month in the Avon Room of the Sheraton Hotel. Secretary, Irvin H. Schram, Jr., 4782 Delma Drive, Pittsburgh 27, Pa. Research finance committee chairman, S. S. Johnston, c/o Weirton Steel Company, Weirton, W. Va.

PORTLAND: secretary, K. B. Humphrey, 2750 N.W. 31st Ave., Portland 10, Oregon.

PROVIDENCE-ATTLEBORO meets third Monday of each month in Providence Engineering Society Hall, 195 Angell Street, Providence, R. I. Secretary, Henry Shavier, 32 Hodges Avenue, Taunton, Mass. Research finance committee chairman, Pierre B. Lonsbury, 78 North Avenue, Attleboro, Mass.

ROCHESTER meets third Monday of each month at the 40 & 8 Club, 933 University Avenue. Secretary, Frederick Johnson, 21 Shire Oaks Drive, Pittsford, N.Y. Research finance committee chairman, Cecil Thornton, 20 Lafayette Parkway, Rochester 10, N. Y.

ROCKFORD meets second Monday of each month in Faust Hotel. Secretary-treasurer, E. J. Budden, 122 Twelfth Street, Rockford, Ill. Research finance committee chairman, David Stockton, the Udylite Corporation, 1943 Walnut Street, Chicago 12, Ill.

SAGINAW VALLEY meets for dinner at 6:45 P.M. and for educational session at 8:00 P.M. at Zehnder's, Frankenmuth, Mich., second Wednesday of each month, September through May, except February. Secretary-treasurer, Dennis J. Goodyne, 1300 N. McLellan St., Bay City, Mich.

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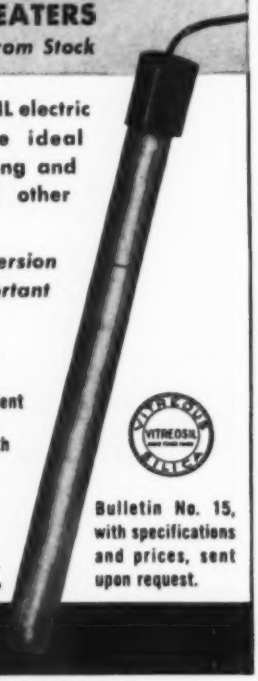

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ST. LOUIS meets second Wednesday of each month at the York Hotel, 6th and Market, St. Louis, Mo. Secretary-treasurer, E. R. Hunleth, 4415 Michigan Avenue, St. Louis, Mo. Research finance committee chairman, to be appointed.

SAN ANTONIO. Regular meeting date to be announced. Secretary-treasurer, Joseph C. Brown, c/o Friedrichs' Refrigerators, Inc., 1117 E. Commerce Street, San Antonio, Texas.

SAN FRANCISCO meets second Thursday of each month, alternating between St. Julien Restaurant, 140 Battery Street, San Francisco, and El Curtola Restaurant, 510 17th Street, Oakland. Secretary-treasurer, Floyd W. Browning, c/o L. H. Butcher Co., 15th and Vermont Streets, San Francisco, Calif. Research finance committee chairman to be appointed.

SEATTLE. Regular meeting date to be announced. Secretary Miss Helen Archibald, 17560 Tenth Ave., N.W., Seattle, Wash.

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SPRINGFIELD meets fourth Monday of each month in the Ivy House, Route 5, West Springfield, Mass. Secretary, Henry L. Heissfeld, 74 Chilson Street, Springfield 8, Mass. Research finance committee chairman, John E. Costigan, 5 Albany Street, Springfield, Mass.

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TORONTO meets second Friday of each month in Royal York Hotel. Secretary, Robert L. Edwards, 1106 Dovercourt Road, Toronto, Ontario, Canada. Research finance committee chairman, K. Wells, 370 Victoria Avenue, Toronto, Ontario, Canada.

TWIN CITY meets first Monday of each month, October through June, in the Covered Wagon (Lodge Room), 114 S. 4th Street, Minneapolis, Minn., with dinner at 6:30 P.M. and business and technical session at 8:00 P.M. Secretary-treasurer, Robert L. Buckley, c/o Industrial Chemical and Equipment Company, 205 11th Avenue So., Minneapolis 15, Minn. Research finance committee chairman, to be appointed.

WATERBURY meets second Thursday of each month in Elton Hotel. Dinner, 6:30 P.M.; meeting, 8 P.M. Secretary-treasurer, Spencer L. Henn, P. O. Box, Drawer B, Cheshire, Conn.

WESTERN ONTARIO meets third Friday of each month in William Pitt Hotel, Chatham, Ontario. Secretary-treasurer, J. Vollans, 1262 McDougall Street, Windsor, Ontario, Canada.

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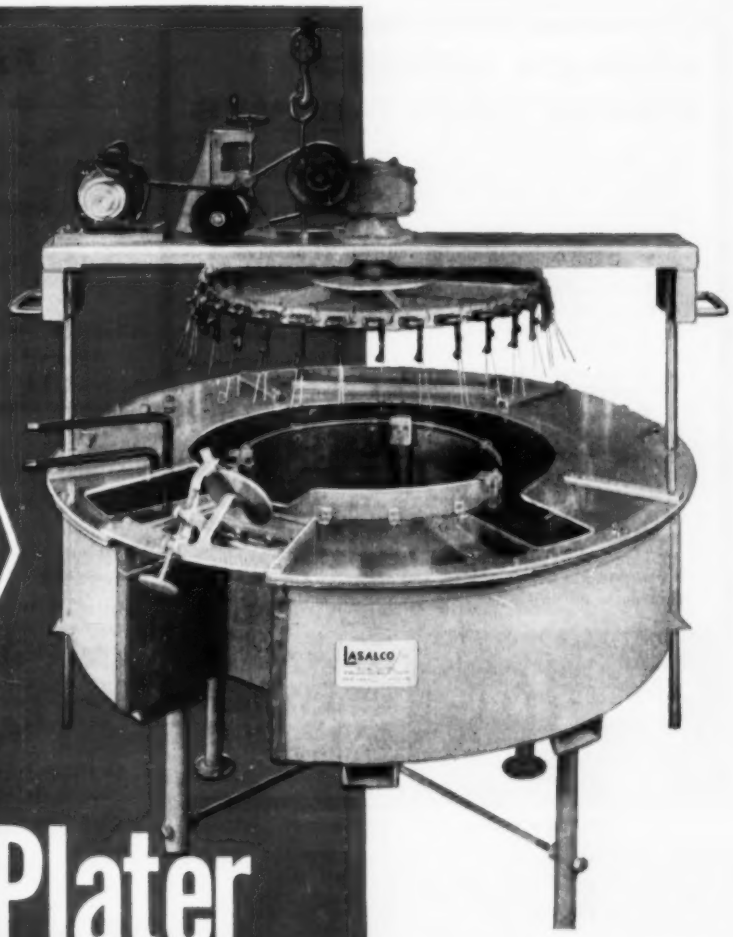
Rotating Cathode Boosts Chrome Plating Up To 5700 Pieces Hourly!



LASALCO'S

Circular Chrome Plater

Lasalco's latest chrome plater with its continuously moving cathode offers some extraordinary cost-cutting and time-saving possibilities for increasing your output of pieces up to 3" long. Here are just a few of its many advantages:

- **One-man loading**
- **Fully automatic unloading**
- **No racks or rack upkeep**
- **Easily raised driving mechanism and cathode wheel gives quick access to coils and anodes. Any parts dropping into tank can be easily, instantly recovered.**
- **Unusually high production—5,733 pieces per hour at 13 seconds; 4,188 pieces hourly at 18 seconds; 2,635 pieces at 29 seconds. Minimum output, 420 pieces at 3 minutes.**
- **Machine is delivered complete, ready to install, and requires only necessary electrical connections and exhaust duct.**

Lasalco's Circular Chrome Plater can be a real profit builder. Write immediately for all the details.

SPECIFICATIONS

Cathode Wheel Diameter 30"; 31 Fingers, 3" Centers
Effective Plating Travel 68.4"; No-plate Travel 25.8"
Anode Rods 24" I.D.; 36" O.D.; ½" Diameter
Center of Anode to Cathode Center 4"
Anodes, Flat 6% Antimonial Lead ¼" x 6". Three 26" Long; Two 24" Long; Two 3" Long; One 5" Lyng.
Tank Diameter 54"; Depth 14"
Solution Capacity 115 Gals., 2" From Top
Heating: ¼" I.D. 6% Antimony Lead Steam Coil
Drive: ⅓ H.P., A.C. Motor; Variable Speed Reduction

LASALCO, INC.

HOME OFFICE
2820 LaSalle Street
St. Louis 4, Missouri
PRospect 1-2990

EQUIPMENT, CHEMICALS AND SUPPLIES FOR ELECTROPLATING, ANODIZING AND POLISHING

IN TEXAS
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Phone: 3-4921

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A 1317.

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When you buy from Udylite you get "More Than A Pound." Udylite gives you these 6 important helps beyond outstanding equipment and tested supplies at no extra cost.

- A pilot plant where we check new plating problems and make recommendations.
- A Customer Laboratory for the testing of your solutions.
- Electrical Service for the latest in current usage recommendations.
- Field Service men who are regularly checking Udylite equipment now operating throughout the United States.
- Engineering Service to advise you regarding the best equipment to handle your new jobs.
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WORLD'S LARGEST PLATING SUPPLIER

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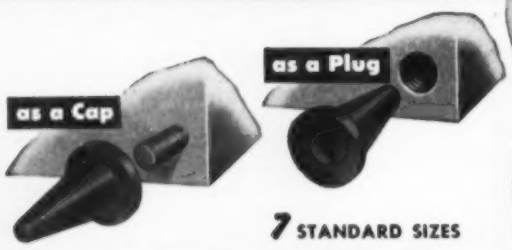
For Metal Finishers!

Pressure Moulded NEOPRENE "CAPLUGS"



7 STANDARD SIZES

	A	B	C	D	E	F	G
TO PLUG HOLE SIZE	1/8-3/16	3/16-1/4	1/4-5/16	5/16-1/2	1/2-5/8	9/16-11/16	5/8-3/4
TO CAP STUD SIZE	3/32-5/32	5/32-3/16	3/16-1/4	1/4-5/16	5/16-3/8	3/8-7/16	5/16-1/2

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Future Meetings

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1954 Exposition and Annual Convention, Municipal Auditorium, Cleveland, Ohio, September 28–October 1, 1954.

PLATING EDITORIAL BOARD, Hotel Statler, Cleveland, Ohio, October 1, 1954.

STANDARDS ENGINEERS SOCIETY, annual meeting, Haddon Hall, Atlantic City, N. J., October 1–2, 1954.

ELECTROCHEMICAL SOCIETY, fall meeting, Boston, Mass., October 3–7, 1954.

NATIONAL FOUNDRY ASSOCIATION, annual meeting, Chicago, Ill., October 6–8, 1954.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, fall general meeting, Morrison Hotel, Chicago, Ill., October 11–15, 1954.

EIGHTH NATIONAL CHEMICAL EXPOSITION, Chicago, Ill., October 12–15, 1954.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS, south central regional meeting, Dallas, Texas, October 12–15, 1954.

AES EXECUTIVE BOARD, Hotel Statler, Cleveland, Ohio, October 23–24, 1954.

FRENCH METALLURGICAL SOCIETY, autumn meeting, Paris, France, October 25–30, 1954.

AMERICAN SOCIETY FOR METALS, National Metal Congress and National Metal Exposition, International Amphitheater, Chicago, Ill., November 1–5, 1954.

MINERALOGICAL SOCIETY OF AMERICA, annual meeting, Los Angeles, Calif., November 8–10, 1954.

FEDERATION OF PAINT AND VARNISH PRODUCTION CLUBS, annual meeting, Palmer House, Chicago, Ill., November 18–20, 1954.

12ND ANNUAL AES CONVENTION AND 4TH INDUSTRIAL FINISHING EXPOSITION, Municipal Auditorium, Cleveland, Ohio, June 20–23, 1955.

Looking for a Better Finish?

4A

TAILOR-MADE
BUFFING AND POLISHING COMPOUNDS
for Aluminun, Brass, Copper, Stainless Steel, Carbon Steel, etc.
CAKE, DIP AND SPRAY
CEMENT AND THINNER
for setting up wheels, belts and rolls

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BRIGHT COPPER

The MacDermid Bright Copper Plating Process developed in 1946 has been constantly improved. Check and compare the advantages listed.

1. **MIRROR BRIGHT DEPOSITS**—takes less nickel to produce bright plate.
2. **GOOD HIDING POWER**—does not magnify defects in base metal.
3. **EASILY CONTROLLED**—does not require a chemist to constantly analyze the solution.
4. **EXCELLENT THROWING POWER**—covers recesses so that nickel solution does not dissolve diecastings and contaminate the nickel.
5. **100% EFFICIENT**—no fuming.
6. **EASILY RINSED**—no problem in covering copper with nickel.
7. **CONTAMINANTS EASILY REMOVED**—chrome-zinc and organics removed by simple chemical treatments without loss of brightener.
8. **NO CARBONATE BUILDUP**—therefore, no dumping of solution or chemical treatment required.
9. **NO COPPER STRIKE REQUIRED**—needs less equipment.
10. **LOW METAL CONTENT**—lower makeup cost and maintenance costs.
11. **ONE BRIGHTENER**—bath does not get out of balance—is easily controlled.

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ROCHELTEX
COPPER ADDITION AGENT

Rocheltex liquid addition agent can be added to any copper cyanide solution. Improves efficiency, reduces cyanide consumption and retards carbonate buildup. Rocheltex aids in producing semi-bright lustrous deposits. Easily buffed. Excellent for use prior to carburizing. Withstands a terrific amount of contamination without destroying operating efficiency. Easily controlled. Can be used for rack type work or barrel plating.

Write for Data Sheet No. 5

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FOR 32 YEARS *Originators* FOR THE METAL FINISHING INDUSTRY

20 FOOT STAINLESS STEEL TANKS POLISHED WITH LEA COMPOUND

Brewing is one of those processes that requires the utmost in sanitary protection — hence the *stainless steel* for this starting tank being fabricated by the Nooter Corporation of St. Louis for the Anheuser-Busch brewery in Los Angeles, the first all stainless steel equipped brewhall in this country.

Brewers too, insist upon *smooth contact surfaces* which promote maximum efficiency in cleaning and sterilization. No rough spots to harbor food bacteria. And the "spic and span" appearance of smooth gleaming surfaces is of no small importance. Hence the polishing!

In the picture above you see a polisher putting the finishing surface on the interior of one of a group of six 20 foot stainless steel tanks and he's polishing it with one of the many grades of Lea Compound.

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Why not let Lea help you with your finishing problem? Write in detail as to your requirements and, if possible, send samples of the work to be finished.

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